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EDITORIAL

TREATMENT

PULMONARY tuberculosis is a treatable disease, but there are few conditions which require so much judgment and careful scrutiny of all available information about the patient before a decision is made to embark on any form of treatment other than that which is included under general sanatorium routine. Judgment is necessary not only from the purely medical standpoint, but also from the administrative aspect. In order that any scheme for the provision of treatment shall work efficiently and economically, it is essential that errors in treatment shall be reduced to a minimum.

The introduction of surgical methods in the treatment of any case will prolong the length of stay in hospital or sanatorium. Frequently a period of sanatorium routine of three to six months is prescribed prior to operative interference, making the aggregate duration of institutional treatment anything from twelve to eighteen months in an uncomplicated case. When complications arise this period may be lengthened to two or three years. If such prolonged residence in a sanatorium results in chronic invalidism with slow deterioration much valuable time, money and skill has been wasted.

As the number of beds in the country available for the treatment of pulmonary tuberculosis is limited and controlled by financial considerations, the results of injudicious treatment mean not only a catastrophe from the patient's point of view, but also the occupation of a bed by one patient for a period which could have served for two or more cases on ordinary

sanatorium treatment. The majority of annual reports from sanatoriums show an increase in the average duration of treatment. This is due to the prolongation of treatment by rest in bed and the extended use of collapse therapy. This increase in the length of stay is reflected in the waiting list, and it seems unwise and most unsatisfactory if cases requiring residential treatment are unable to obtain it because other patients are receiving elaborate specialised treatment, particularly if such treatment is being given to cases with a doubtful prognosis.

It is easy to say that the situation must be met by increasing the number of beds for tuberculosis, but that cannot be done indefinitely, and even in a moderate degree it involves considerable expenditure. Tuberculosis is only one disease amongst many. Other conditions, many of which respond excellently to treatment and are definitely curable, demand accommodation. In his enthusiasm the phthisiologist is apt to forget that he does not give very good return, as far as results of treatment are concerned, for the expenditure involved. Drolet has recently shown that the case mortality of tuberculosis is approximately the same today as it was twenty years ago, in spite of all the efforts of modern treatment. So often the records of patients show that the slow progress of the disease can only be temporarily checked by institutional treatment and that the limit of improvement is reached in a comparatively short time. It thus behoves us to be careful in recommending such cases to submit to a costly and lengthy period of residence at a sanatorium when the ultimate result is likely to be one of no material improvement.

From the last report of the Chief Medical Officer to the Ministry of Health it will be seen that there were, in 1936, 3,696 more positive cases on the dispensary registers than in 1932. This means that the demand for treatment at the public expense is not declining, but rather tending to increase. The duration of institutional treatment is increasing and the field to which collapse therapy is being applied is widening. Along with these conditions a large section of the public are becoming seriously alarmed at the rapid increase of public expenditure on local government services.

Further beds may be allotted for the treatment of tuberculosis, but not in sufficient numbers to satisfy the optimists who so often visualise the complete cure of the majority of cases by prolonged residential treatment. The solution of the problem depends upon the careful judgment of the physician in selecting the right case for prolonged treatment by rest or operative procedures. If there is considerable doubt as to the final result

it is better for the patient and his fellow-sufferers awaiting treatment that the hand of the surgeon is restrained and directed to more suitable cases which will derive permanent benefit from the ordeal. It will be necessary to develop a finer sense of proportion as to the ultimate value of treatment, and only a more accurate assessment of prognosis of each case can ensure the efficient working of the facilities at our disposal.

GENERAL ARTICLES

A METHOD FOR THE TREATMENT OF PULMONARY TUBERCULOSIS BY INTRA-PULMONARY INJECTIONS OF GELATIN ACRIFLAVINE CALCIUM CHLORIDE*

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Introduction.

Collapse therapy in general, and artificial pneumothorax in particular, are considered the principal active methods of attack upon pulmonary tuberculosis. Yet it has been authoritatively stated by Fishberg that "most clinicians who are competent to speak find that less than 5 per cent. of all cases of active pulmonary tuberculosis can be considered ideal for pneumothorax treatment. In my own experience I have found less than 5 per cent. of cases in which I could conscientiously urge this form of treatment, and of these at least one-third had sufficient pleural adhesions to render the attempt at collapsing the lung more or less futile. . . . On the whole it may be said that pneumothorax treatment is perhaps the most effective measure to combat the ravages of tuberculosis of the lungs, but that it is not applicable in the majority of cases. . . . Over 95 per cent. of patients with tuberculosis of the lung must still be treated along other lines." Again, it is well known that not all the selected cases run an uneventful, safe, or short course to recovery, but that approximately half the number will develop fluid or other complications, and the treatment may have to be prematurely abandoned. Thus, while many individual cases derive benefit from the adoption of this procedure, others presenting comparable pulmonary lesions have to be denied the treatment because of pleural adhesions, etc.

Of phrenicectomy and thoracoplasty it may be stated briefly that whilst the former is a simple and very useful procedure in good hands, it

* Paper read at the Oxford meeting of the Tuberculosis Association in April.

also has a limited use; and the latter operation is of such a nature that many patients who are relatively able to withstand it are reluctant to consider a course which is fraught with so much risk. The gain in many instances will be problematical.

Mention may be made at this juncture of tuberculin and gold therapy; both of these treatments started off with the highest expectations, only to prove inadequate. It has been suggested by Fishberg that much of the benefit accruing is psychotherapeutical.

Under these circumstances it is not surprising to find phthisiologists exhibiting signs of scepticism and defeat. If 90 to 95 per cent. of all cases have to depend largely on rest and sanatorium régime, entailing prolonged absence from home and employment, with consequent personal and economic difficulties, no apology is needed for any attempt to increase our therapeutic armamentarium.

At one time considerable interest was evinced and work done throughout the world on the relation of calcification to tuberculosis; it was common knowledge that healed lesions frequently showed deposition of lime salts, and also that workers in lime pits were relatively free from tuberculosis. Hence many artifices were adopted to impregnate the tubercles with lime, but without success. For example, patients were repeatedly exposed to an atmosphere highly charged with lime dust, in an endeavour to calcify the lesions; others were given series of injections of various calcium preparations which were subsequently found to have been eliminated from the body at the instigation of the parathyroid glands, whose function it is to regulate the concentration of calcium in the blood. The object appeared encompassed with difficulties and unattainable, Wells and Long (1932) remarking after a survey on the subject that " whether administration of lime salts by any method or any route will increase the rate of calcification is problematical."

In 1931 one of us introduced a new gelatin medium for intrapleural injection; the treatment was termed gelatinothorax, and beneficial clinical results were obtained. Further work on animals (Hunter and Bell, 1934) showed that this gelatin medium converted fibrous tissue into a hyaline state, and with the addition of calcium chloride to the preparation, calcification was invariably induced.

It is also relevant to point out that in a study on the Jensen rat sarcoma (Hunter, 1936) hyaline change and calcification were consistently effected by parenteral injections of the medium.

These findings have been supported by a pathological study of a human case (Hunter, 1935) in which the results obtained were identical with those produced experimentally. In that article it was suggested that the medium

might be useful in cases presenting a localised pulmonary lesion, and intrapulmonary injections were advocated.

As space is necessarily limited, we would draw attention to the fact that this article is a sequel to the previous work, and that, in order to gain a comprehensive idea of our aims and methods, reference should be made to the earlier papers.

Preliminary Clinical Observations.

Since 1930 the medium (gelatin acriflavine calcium chloride, termed "G.A.C.C.") has been employed in cases of empyema and pleuro-pulmonary fistula, etc., with good results. Three years later the first intrapulmonary injections of G.A.C.C. were made in Case I. described below. Since that time the number of cases undergoing intrapulmonary treatment has steadily increased; in some instances patients have been so impressed by a room-mate's improvement that they have requested similar treatment.

It was hoped to present a series of cases for review, but as we have recently altered and improved the medium this will not be possible for a time. It was decided under the circumstances to make a preliminary report, giving full details of three cases, with follow-up, in which the original medium was employed. In the subsequent pages we supply all the information required by any who may desire to utilise the modified medium without further delay.

Although intrapulmonary injections were performed almost fifty years ago, it still appears to most minds a highly dangerous practice. Notwithstanding the fact that we have ourselves succeeded in giving large biweekly pulmonary injections to small animals over a long period of time, the apprehension persisted, irrationally enough, when we were confronted with the same project on a lesser scale in the human. As a result the method was only employed in a small way at the outset, and often in hopeless cases. Confidence grew with the number of injections, and when sixty had passed by without any alarming effect, the safety of intrapulmonary injection was accepted as proved, provided the necessary precautions were observed.

Case I.—Male, thirty-three years. Admitted 13/11/33. The condition on admission was one of chronic ulcerative phthisis, particularly affecting the upper half of the left lung, with cavitation and active disease. The root of the right lung was also affected. During the past year he had complained of cough, lassitude, loss of weight, and night sweats, and six weeks before admission had a small hæmoptysis. In another sanatorium he had gained about 42 pounds in weight, but the condition on the left side was stated to be "a little more active."

Clinical Notes.—13/11/33: Artificial pneumothorax induced on left side. Weekly refills continued until 16/5/34.

16/5/34: A/P abandoned as unsatisfactory. Collapse imperfect, and sputum TB++. Weight falling. Gold therapy commenced.

11/7/34: Cavity greatly increased in size (*vide* Fig. 1). Sputum T.B.+++.

24/7/34: Phrenicectomy performed on left side.

15/8/34: Improving. Started second course of gold therapy.

23/1/35: Feeling ill; losing weight and off sleep. Cough bad. Back to bed.

20/2/35: No progress. Sputum T.B.++++. Activity in left upper two-thirds; also in right apex and root, to less degree.

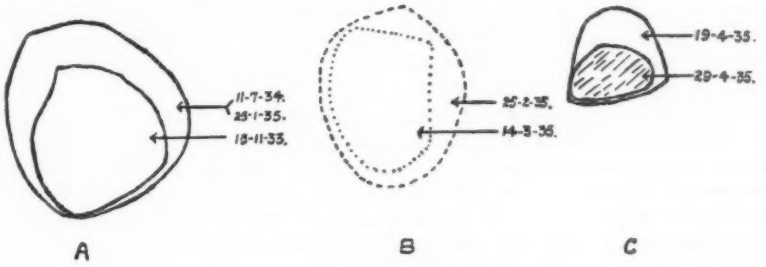

FIG. 1 (CASE I.).

A. The small ring represents the cavity on admission. The large ring configures the cavity after eight months' treatment, including artificial pneumothorax and gold therapy. During the next six months the cavity remained unaltered after further gold therapy and phrenicectomy.

B. Five days after the first intrapulmonary injection of G.A.C.C. 5 per cent. the cavity contracted. On the date of the third injection a further reduction was observed.

C. About a month later (19/4/35) the cavity was considerably reduced. During the next ten days the then existing cavity was halved (see shaded area).

(1) 21/2/35: Intrapulmonary injection of 4·5 c.c. G.A.C.C. into left apex. Temperature normal. No reaction.

(2) 27/2/35: Intrapulmonary injection of 9 c.c. G.A.C.C. into left apex. Temperature up for four and a half days, maximum 100·0° F.

(3) 14/3/35: Intrapulmonary injection of 10 c.c. G.A.C.C. into left apex. Temperature up one and a half days, maximum 100·0° F.

27/3/35: Sputum still T.B.++++. Weight rising, and feels better.

19/4/35: Cavity shrinking (*vide* Fig. 1). Up one hour daily.

15/5/35: Lungs apparently quiescent, but sputum T.B.+. Up five hours daily.

12/6/35: Up all day.

26/6/35: No signs of activity noted. Sputum T.B. negative. On second walk.

12/7/35: Very well. Wants to go home. Discharged.

Summary.—After fifteen months' treatment, including pneumothorax, phrenicectomy, and two courses of gold therapy, the patient was losing ground. Finally, intrapulmonary injections were instituted. Three injections were given during the course of twenty-one days, the patient's condition rapidly improved, and he was discharged four months later.

He was invited to visit the sanatorium for examination and X-ray almost two and a half years later (10/11/37). The lungs were apparently quiescent. There was no evidence of activity in either lung.

He stated that he frequently walks twelve miles in a day without fatigue.

His sputum was obtained on 18/11/37; after prolonged search only two tubercle bacilli (one pair, intracellular) were found.

Recalled for examination six months later (11/5/38). The lungs were apparently quiescent and the cavity undetectable. He weighed 12 stone 9 pounds. His general condition was excellent. He walks twelve miles daily. The sputum was positive.

Case II.—Male, thirty-six years. Admitted 24/7/36. The condition on admission was one of chronic ulcerative phthisis, with multiple subapical cavities in the right lung. The hilum was also involved, and there was some activity in the left apex. The patient had had a left-sided pleurisy in May, 1935. He returned to work, but in May, 1936, developed a pain in the right side and consulted his doctor, who found that his sputum was T.B. positive. Admitted to sanatorium two months later. He had a history of cough, spit, marked lassitude, and loss of weight.

Clinical Notes.—24/7/36: Blood sedimentation rate, 12·5, 26·5, 39·5, 50 per cent.

5/8/36: Left apex active. Trachea drawn over to right side and diaphragm pulled up. Weight rising, and general condition fairly good. May be able to have collapse therapy on right side when left apex has cleared up.

2/9/36: Right apical cavity still open, with activity around it. Rising sedimentation rate, 25·5, 39·5, 48·5, 53·5 per cent. Try G.A.C.C.

(1) 3/9/36: Intrapulmonary injection of 8 c.c. G.A.C.C. into right apex. Temperature up for twenty-four hours, maximum 100·2° F.

(2) 10/9/36: Intrapulmonary injection of 8 c.c. G.A.C.C. into right apex. Temperature up forty-eight hours, maximum 100·0° F.

(3) 19/9/36: Intrapulmonary injection of 8 c.c. G.A.C.C. into right apex. Temperature up thirty-six hours, maximum 99·0° F.

(4) 24/9/36: Intrapulmonary injection of 6 c.c. G.A.C.C. into right apex. No reaction. Maximum temperature 98·0° F.

14/10/36: No activity noted, and cavity smaller. Better generally. Splendid appetite. Sputum T.B. negative. Blood sedimentation rate, 6, 22·5, 27, 49·5 per cent. Up for one hour daily.

25/11/36: Up eight hours daily. Weight 11 stone 1 pound.

23/12/36: Lungs apparently quiescent. Cavity at right apex still patent. Sputum T.B. negative. Up all day (twelve hours).

27/1/37: No activity noted in chest, but cavity at right apex still patent.

Weight stationary. Blood sedimentation rate, 5, 13, 18, 38·5 per cent. On third walk (one mile).

10/3/37: Cavity much smaller, and no activity noted. Becomes a Grade II. worker. States that he feels more vigorous than for years past.

18/3/37: Weight, 10 stone 13 pounds (on admission, 9 stone 11 pounds). Sputum T.B. negative. Discharged.

Summary.—Patient had 3×8 c.c. and 1×6 c.c. intrapulmonary doses of G.A.C.C. into the right apex within a period of twenty-one days. Total residence, thirty-four weeks. Discharged twenty-five weeks after last injection. Has made steady progress.

Invited to visit sanatorium over seven and a half months later (30/10/37) for examination. Fully six months ago he took up his duties again, and has been working steadily since; his hours are 9 a.m. to 5 p.m., and he feels fit after the day's work.

On this visit the skiagram showed a considerable degree of fibrosis, and there was no evidence of cavitation or activity in the right apex; the hilum was also improved. In the left apex fibrosis had proceeded further, and there was no evidence of activity. A sputum was obtained on 17/12/37; there was no evidence of tuberculosis in the smears examined.

Recalled for examination six months later (11/5/38); no further change was noted. The lungs were apparently quiescent, but the sputum was positive. Has been at business regularly for over one year, but admits that latterly he has been overtaxing his strength by gardening in the evening.

Case III.—Male, thirty-three years. Admitted 15/3/37. The condition on admission was one of chronic ulcerative phthisis affecting the hilar area of the left lung, with cavitation and definite infiltration spreading towards the base. The right root was also affected. The disease was very active on the left; much less so on the right. The patient had had cough, spit, and slight night sweats. He had lost 7 pounds in weight. Sputum T.B.+. History of slight hæmoptysis.

Blood sedimentation rate, 23, 33, 48·5, 56·5 per cent.

Clinical Notes.—(1) 18/3/37: Intrapulmonary injection of 10 c.c. G.A.C.C. into left lung, seventh interspace, posteriorly. Temperature up three days, maximum 102·0° F. No complaint.

(2) 24/3/37: Intrapulmonary injection of 10 c.c. G.A.C.C. into left lung, eighth interspace, posteriorly. No reaction.

(3) 31/3/37: Intrapulmonary injection of 10 c.c. G.A.C.C. into left lung, ninth interspace, posteriorly. Temperature up three days, maximum 99·6° F.

(4) 7/4/37: Intrapulmonary injection of 10 c.c. G.A.C.C. into left lung, ninth interspace, posteriorly. No reaction, and feels very well.

(5) 14/4/37: Intrapulmonary injection of 10 c.c. G.A.C.C. into left lung, eighth interspace, posteriorly. Temperature up three days, maximum 100·0° F.

21/4/37: The lower lobe of the left lung showed a degree of consolidation and an absence of any signs of activity. Blood sedimentation rate very high (36, 50·5, 55, 60 per cent.). Sputum T.B. negative.

2/6/37: Stated that he felt better than for many months.

9/6/37: No activity noted. Sputum only a trace, and T.B. negative. Weight well up. Sedimentation rate, 3·5, 11·5, 22·5, 44 per cent. Allowed up eight hours daily.

30/6/37: Has been resting outside, and today commenced on walks. Weight 8 stone 10 pounds 8 ounces (weight on admission, 7 stone 9 pounds 12 ounces). Highest known previous weight 8 stone 6 pounds. The sputum showed tubercle bacilli before treatment, but became and remained negative after intrapulmonary injections. Before treatment his sputum averaged 12 drachms by weight daily, and during treatment it varied from 10 to 20 drachms. Five weeks after the injections had ceased the sputum dropped to a trace, and remained so until his discharge.

6/7/37: Discharged. Wanted to go home for holiday.

Summary.—Patient had 5×10 c.c. doses of G.A.C.C. within a period of twenty-nine days. Total residence sixteen weeks. Discharged ten weeks after last injection.

Visited sanatorium at our request over three months later (10/10/37) for examination. On this date the skiagram showed fibrosis of the left hilar area and resolution of the infiltrated area extending towards the base. The root of the untreated right lung appeared to have benefited also, probably from the improvement on the left side. Clinically both lungs were apparently quiescent; the patient was symptom-free and feeling very fit. The sputum was examined on 8/12/37, and was T.B. negative. Recalled for examination six months later (11/5/38). The lungs were apparently quiescent. He was symptom-free. His weight was 8 stone 8 pounds. Sputum examined 14/5/38, and found T.B. negative.

Case I. was the first to receive intrapulmonary injections of G.A.C.C. Cases II. and III. were the first cases to receive intrapulmonary injections without any other treatment.

A Modification of G.A.C.C.

Experimental Observations.

Although the clinical results obtained with G.A.C.C. were so encouraging, it was conceived that a much heavier, more sluggish, gelatin medium would tend to remain intracavitary, would leave a thicker coating on the cavity wall than the original strength was apt to do, and, further, a much greater amount of gelatin would be available in the tissues. It was first necessary, however, to obtain some information regarding its compatibility, dosage, and tissue response, if any; hence a series of experiments on animals was arranged to investigate the problem.

Preliminary work suggested that the maximum concentration of gelatin compatible with preparation and manipulation was in the region of 30 per cent.; the original strength was only 5 per cent. gelatin.

At the outset we realised that one of the major problems would be the

high temperature at which the injections would necessarily have to be given, as at temperatures convenient for the manipulation of the original medium the modified preparation was almost solid, and would be, therefore, impracticable for the purpose, and, indeed, as we shall explain later, a menace to the recipient.

The method of preparation of the modified medium is detailed below. The procedures should be carried out strictly in accordance with the instructions given, and we strongly urge that the quantities, as regards acriflavine, calcium chloride, etc., should be scrupulously observed.

G.A.C.C. "B."

Method of Preparation.

Sodium chloride	0·85 per cent.
Calcium chloride	5·00 per cent.
Gelatin	30·00 per cent.
Distilled water	100 c.c.
Acriflavine	1 to 2,000

To prepare 1 litre obtain a 2-litre flask and—

(1) Add 8·5 grammes sodium chloride.

(2) Add 900 c.c. of warm distilled water and shake. (The warm water facilitates Stage 3.)

(3) Weigh 300 grammes sheet gelatin and introduce into flask. (This is best done by taking two sheets at a time and rolling them into a small cylinder, and pushing down the neck of the flask with a spatula.) Shake well.

(4) Heat at 100° C. in steamer for ten minutes, and then rotate vigorously.

(5) Adjust the reaction to the alkaline side of neutrality or to pH 8. This may be conveniently tested by litmus paper. One litre will require approximately 25 to 30 c.c. $\frac{5}{N}$ NaOH.

(6) Autoclave for fifteen minutes at 15 pounds pressure.

(7) Filter immediately after autoclaving through a sheet of absorbent cotton-wool, with a fine cheese cloth underneath for support. Prevent undue loss in the filter.

(8) Add the following to the filtrate:

(*a*) 50 grammes calcium chloride dissolved in 100 c.c. distilled water. Shake well, and when completely dissolved filter through Chardin filter paper while chemically hot.

(*b*) 0·5 gramme acriflavine. (If any of the acriflavine adheres to the

inner wall of the flask neck, tilt the contents until it is dissolved into the medium.) Shake well.

(9) Autoclave again for fifteen minutes at 15 pounds pressure.

(10) Decant while hot into sterile amber bottles, taking all aseptic precautions, and apply sterile rubber caps and tie firmly with twine. Store in a dark cupboard.

Experimental Series I.

Results of Intrapulmonary Injection with the Modified Medium in Healthy Rabbits.

It was decided to subject a number of healthy rabbits to intrapulmonary injections with the heavier medium, and also to ascertain its effect with and without calcium salts. Accordingly, two groups of rabbits were arranged:

Group A (5 rabbits): To receive intrapulmonary injections of gelatin acriflavine (G.A. " B ").
Group B (5 rabbits): To receive intrapulmonary injections of gelatin acriflavine calcium chloride (G.A.C.C. " B ").

It was also decided that in this series no attempt should be made to determine if the needle-point at the injection was in a bloodvessel or bronchus, and to compare the results with a further series in which particular care would be taken to avoid bloodvessels.

The medium was injected at high temperatures, and the following procedure was adopted for each injection:

A rubber-capped bottle of the preparation was placed in a pan of boiling water and steadily heated by a Bunsen burner; it was only removed from the pan to withdraw the amount for injection, and was returned to the still boiling water. The heat of the bottle was such that a towel had to be wrapped round the bottle for handling. The syringe was kept heated, and cleaned out between the injections by sucking up and expelling almost boiling water. When the medium was withdrawn into the syringe it was immediately injected into the animal; the syringe should be uncomfortably warm to the gloved hand during the manipulation. When introduced into the lung the temperature of the medium would not be less than 80° C.

We had at that time grave misgivings as to the reaction such heated inoculum might have on the animal, and were pleasantly surprised when no immediate untoward manifestations were displayed.

Summary of Results.

All the animals in this series received injections in the right lung; the left lung may be considered as a control.

Group A, in which gelatin-acriflavine alone was used, showed in the treated lungs surprisingly little reaction to the injections, a few areas of collapse, fibrosis, and hyalinisation in the right lungs being the only positive findings.

Group B, in which gelatin acriflavine calcium chloride was employed, showed, however, marked evidence of hyalinisation, calcification, fibrosis, etc., in the treated lungs. Foreign body giant cells were numerous in these tissues. A remarkable feature was the presence macroscopically of firm, inspissated, caseoid material in the right lung of the three animals of this group. Histologically it consisted of hyaline or calcareous material, and showed no tendency to softening or disruption from the surrounding structure. The left lungs were unaffected.

Altogether seventy-nine intrapulmonary injections were given in this series without ascertaining the position of the needle-point at the moment of administration (*e.g.*, if in a bloodvessel or not), with the result that two animals died exhibiting symptoms of cerebral embolism.

In no instance in this series was there any free fluid in the pleural cavities.

There was no evidence to suggest that the high temperatures employed at injection had any inimical effect.

Series II.

Results of Intrapulmonary Injections of the Modified Medium in Animals infected with Tuberculosis.

Although bovine tuberculosis in the rabbit is such an acute process, and rapidly involves both lungs in a caseous pneumonia, together with gross involvement of the kidneys and other organs, and is therefore not comparable with human phthisis, it was decided to set up a series employing rabbits infected with bovine tuberculosis in an endeavour to elicit any information as to the action of the medium under these conditions. For instance, what effect will the concentrated protein inoculum, given at high temperatures, have on an already toxic organism?

Moreover, in Series I. no attempt was made to ascertain if the needle-point was in a bloodvessel or bronchus, with the result that two animals succumbed to cerebral embolism. In the present series precautions were to be taken to obviate such an outcome.

Thirty rabbits were obtained for experiment, but one died before the work commenced. Hence twenty-nine rabbits were inoculated intrapulmonarily on the right side, through the third intercostal space, with 0·1 c.c. of an emulsion of bovine tubercle bacilli. The emulsion had been

prepared from a bovine caseous gland; only three tubercle bacilli were found on a film made from one loopful of emulsion.

The following groups were arranged:

Group C (6 rabbits): No treatment.
Group I. (5 rabbits): To receive intrapulmonary injections of gelatin acriflavine.
Group II. (6 rabbits) } To receive intrapulmonary injections of
Group II.*a* (6 rabbits) } gelatin acriflavine calcium chloride 5 per cent.
Group III. (6 rabbits): To receive intrapulmonary injections of gelatin acriflavine calcium chloride 10 per cent.

Treatment was withheld in Groups I. and II. until a fortnight after inoculation with tubercle bacilli; Groups II.*a* and III. were delayed for three weeks.

Group III. had been set up to investigate the possibilities of employing 10 per cent. calcium chloride instead of the usual 5 per cent.

All the intrapulmonary injections were made through the third intercostal space on the right side. Each animal received approximately 8×2 c.c. doses during a period of twenty-eight days.

Summary of Results.

The results obtained in Groups I. to III. tend to show that there has been some retardation or inhibition of the tuberculous process in the upper and middle lobes of the treated right lungs. It was generally noted that the lower lobe of the right lung was more diseased than the superior lobe, although the infection was induced in the upper lobe. Further, all the injections of the medium were made high in the right lung. The untreated left lungs were usually more caseous and voluminous than the treated side. The control group, on the other hand, showed that the upper and middle lobes of the right lung were more involved than the lower lobe or the left lung; this was to be expected, as the tubercle bacilli were injected into the upper lobes of the right lung.

In no instance in this series was there any free fluid in the pleural cavities.

Hyaline change, calcification, and fibrosis were a common finding in the treated lobes. The amount of calcium deposition found in two animals in the control group was not at all comparable with the findings recorded in the treated rabbits.

There was some evidence to show that the initial injections may stimulate the reticulo-endothelial system, and induce an enormous inflow of macrophages or phagocytic cells to the area inoculated, the alveoli being inundated

with these cells and the lung consolidated. At a later stage the consolidated lung may undergo hyaline change and calcification, involving not only the cells within the alveoli, but the lung structure itself.

Many cases, however, showed no evidence of this cellular invasion. For example, in many instances an unexplained collapse of the part or lobe was observed; in others the thickened alveolar walls were hyalinised or calcified; and, again, a replacement fibrosis of the entire structure was sometimes obtained. Any of these features may be combined in the same lung, or may occur separately. Nevertheless, if we exclude a clear-cut collapse, the general and final effect was a hyalinisation of the pulmonary parenchyma embracing the alveoli, connective tissues, bloodvessels, cellular elements, and caseous material. The healthy bronchial epithelium was least affected, and this will be readily understood when we consider that precautions were taken to avoid injections into blood or air vessels. At any rate, the medium would have had to be inoculated into the bronchi to have any result, and in the case of a healthy bronchial wall it would, we believe, have little effect. When, however, the bronchial epithelium has become impaired by disease, then, as we have seen in our experiments, it readily succumbs to the action of the medium.

Bloodvessels, on the other hand, are very prone to hyaline change and calcification, and absorb the medium from the parenchyma via the adventitial coat.

Altogether twenty-three animals received a total of 172 lung punctures; this includes nine instances in which the puncture had to be repeated due to the animal jerking the needle out of the thorax.

In this series the following simple precautions were observed to ensure that the injection was not made into a bloodvessel or air space: When the needle had penetrated to about the desired point in the substance of the lung the plunger of the syringe was withdrawn to find if blood or air would enter the syringe, and, if not, the injection was given slowly at that point. If, however, blood or air was obtained, the needle was advanced or withdrawn slightly, a further test made, and if satisfactory the injection completed.

We were pleasantly surprised to find that in 172 lung punctures we obtained only six air findings, denoting that the needle was in a bronchus or air space, and a further six in which there was evidence of having entered a bloodvessel, making in all twelve instances, which was barely 7 per cent. over the series.

In three of these a little difficulty was experienced, and the following notes are supplied from the laboratory journal:

(1) Tested and drew air; withdrew needle slightly and found satisfactory; injection proceeded, but shortly after the animal made snuffling

noises and a further test was made, when air was again obtained; the needle was again withdrawn a little and found all right, when the injection was completed.

(2) Drew air on first test; withdrew but found blood; next attempt furnished air, but the third movement of the needle proved satisfactory, and the injection was given without difficulty.

(3) Drew air in first position; withdrew and found satisfactory. Injection proceeded, but animal commenced snuffling, so tested again and obtained blood; withdrew and acquired suitable position, when injection was completed without difficulty.

These details were observed in three different rabbits when each animal was receiving its first injection. It is noteworthy that they subsequently received a number of injections without any further complications.

In Series I. seventy-nine intrapulmonary injections were made without testing for blood or air, and two animals died due to cerebral embolism.

Observing a few simple precautions, we administered 172 intrapulmonary injections in Series II., and there was no instance of any symptom of cerebral embolism.

The temperature (rectal) was obtained before each injection in both series, but, apart from the self-explained fact that in Series I. (healthy animals) they tended to be lower than in Series II. (tuberculous infected animals), no effect was noted which could be attributed to the intrapulmonary injections. As we shall show later, in human cases of tuberculosis treated with the medium there was in most instances a typical rise and fall in the temperature following each injection, but no such reaction was observed in the experimental animals of either series.

Many writers suggest that no treatment will be efficacious in the treatment of human tuberculosis unless it arrests or cures bovine tuberculosis in the animal, which is unreasonable. It is possible that an area may be efficiently treated and the disease arrested at that part, only to be reinfected in greater degree by the multiple and widespread gross lesions which are rapidly set up by bovine tuberculosis in the animal body. In the human, on the other hand, phthisis is generally confined to the lung tissue, and treatment in hopeful cases is directed to one area which may be giving rise to concern. If this area or lesion is satisfactorily dealt with, then, whilst reinfection may possibly occur, it is not so certain to do so as in the rabbit suffering from bovine tuberculosis. As a matter of fact, recrudescence and not reinfection is the major fear in many cases of pulmonary phthisis.

Preliminary Clinical Notes on the Application of G.A.C.C. "B" in Pulmonary Phthisis by Intrapulmonary Injections.

As the experimental results were reasonably satisfactory, it was decided to give the new medium (G.A.C.C. "B" 5 per cent.) a clinical trial. Only a few cases were tried at the beginning, and naturally in patients who had had every available treatment and were still regressing. Surprisingly good results were obtained in some cases, but in others the failure of any treatment was a foregone conclusion. Nevertheless, it became strikingly apparent that even in the most advanced cases toleration for the treatment was pronounced.

The following procedures were adopted and rigorously observed when giving intrapulmonary injections:

The area or cavity to be injected and the point, line, and depth of puncture are carefully determined. High apical, subhilar, and basal injections are best given posteriorly. Subapical injections are more easily given anteriorly. Stereoscopic photographs are helpful. If tomographs surmount their difficulties, localisation will be easier. Clinical examination gives a good idea as to which approach to use. Beware of scapular movements; avoid intercostal vessels and nerves. Visualise the anatomical relations of the needle-point. Ensure that there is sufficient light to show up blood or air bubbles in the glass syringe. Intrapulmonary injections should not be attempted in a dim light, nor in an awkward position.

The patient lies comfortably in bed in such a position that the lung for injection is at a lower level than its fellow, thereby discouraging or preventing outflow of the medium from the cavity. The skin is prepared and painted with metaphen. The patient is requested to avoid coughing, if possible, or in any case to cough as gently as possible; a menthol lozenge helps.

Previously place a rubber-capped bottle of G.A.C.C. "B" in a basin of boiling water, actively bubbling on an electric hot-plate, until the medium almost reaches boiling point. At the same time boil up a 20 c.c. Record syringe (with the piston outside the cylinder, of course) and a very sharp and bevelled needle about 5 inches long and 18 British wire gauge. Cool the piston in methylated spirits. Pour 16½ c.c. of the heated medium into the hot syringe, insert the plunger, fix the needle, and expel all air from the needle. These manipulations should be carried out aseptically and expeditiously, so that the temperature of the medium in the syringe is still over 80° C.

Without delay insert the needle at the predetermined point on the thorax at right angles to the skin, and gradually advance it, *maintaining*

suction all the time, until the desired point is reached. *Inject the medium slowly*, leaving about ½ c.c. in the syringe. Withdraw the needle, maintaining suction throughout. A collodion patch is placed over the puncture.

A cavity penetrated by the needle-point gives to suction a free rush of air, a bronchus less air, and lung parenchyma only reluctant bubbles. Caseous or fibrosed areas do not permit suction. Occasionally a blood-vessel is punctured, but on no account must the medium be injected directly into the blood stream. When blood is drawn into the syringe the needle is steadily advanced until it emerges from the other side of the vessel, and the desired point is reached when the injection is given. Punctured vessels quickly close, and cause only very slight and transient hæmoptysis.

A very hot medium and syringe, a sharp needle, and maintained suction are essential for smooth, safe, and easy manipulation. Easy movements are necessary; force incurs the risk of uncontrolled jerks.

Apart from other considerations, rubber gloves are required owing to the heat of the syringe. The injections are almost painless, and patients who have had artificial pneumothorax treatment state that the injection is comparable. No patient has complained of, or even mentioned, the heat of the inoculum, and the majority do not even cough.

The patients greatly appreciate the operation being performed in their own beds rather than being wheeled to the X-ray room and having the injection under radioscopic control. Taking every factor into consideration, the bedside method is undoubtedly the better, both for the patient and the operator.

Reactions to Intrapulmonary Injections of G.A.C.C. "B."

At the time of going to press 180 intrapulmonary injections in human subjects have been given; this includes fifty-eight instances in which the original medium was employed. We believe that the so-called "pleural shock" of artificial pneumothorax is merely a euphemism for cerebral embolism due to insufficient care. There is no such clinical entity as pleural shock. No sign of cerebral embolism occurred in the series.

Three or four injections were given in each case at weekly or longer intervals, allowing any reaction to subside before the next dose was given. The dosage per injection (16 c.c.) has proved satisfactory. A further course may, if necessary, commence immediately after the first series, but generally it will be found advisable to wait a few weeks in order to determine the effect of the early injections. Needless to say, the number of injections required will be in proportion to the amount and extent of disease existing in the lung, as the medium appears to be confined to the lobe injected.

The reaction to the inoculum varied from individual to individual, and did not appear to be strictly related to the patient's condition; some patients were unaffected throughout a series of injections, or perhaps only reacted to one or two doses. A few patients, however, reacted strongly to each injection.

These reactions, in their order of frequency, may be stated as follows: (*a*) Elevation of temperature and acceleration of pulse; (*b*) malaise or sickness; (*c*) anorexia. All were of short duration. One individual developed an urticaria after the third injection, his only reaction. This disappeared

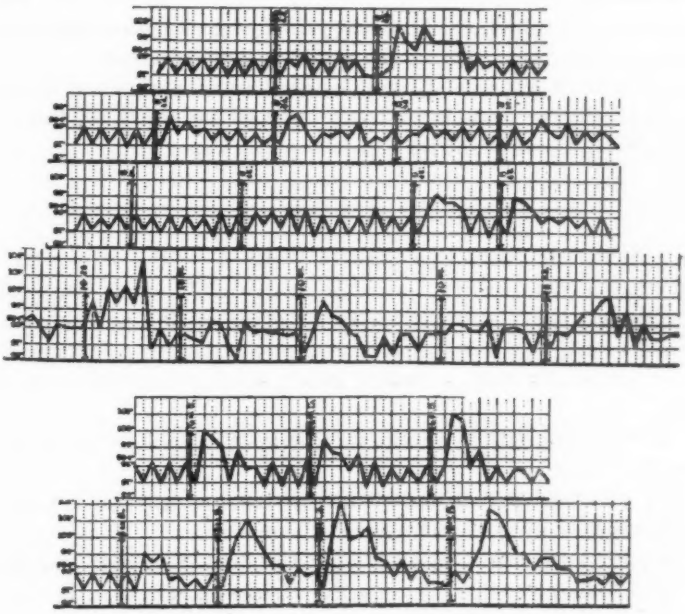

FIG. 2.

within a few hours. He derived considerable benefit from the treatment. A number of patients developed prodigious appetites shortly after the cessation of treatment.

A few temperature charts are adduced (Fig. 2) to show the varied results obtained during treatment, and employing both the original medium and G.A.C.C. "B." It will be observed from Charts I. to IV. that the degree of elevation of temperature does not appear to depend on the amount injected, nor is the reaction peculiar to any one injection of the series. Further, Charts V. and VI. were abstracted from cases undergoing treatment

with G.A.C.C. "B." If we consider that the original medium contains only 5 per cent. gelatin, and the "B" medium 30 per cent. gelatin, then comparing Charts IV. and V., we find that the additional protein inoculated in the form of gelatin was approximately ten times greater per injection. It appears, therefore, that the elevations of temperature cannot be explained on the grounds of protein shock. Rather do we believe that the dominant factor is whether the injection is intracavitary or intrapulmonary, for we have observed that where the injection has been made when free air has been furnished within the syringe, as described in the technique, then the temperature has not appreciably altered. When, however, the injection was given into the substance of the lung, then pyrexia ensued, probably due to tension at that part. Hence the need for slow injection.

A considerable amount of hæmatological investigation was undertaken throughout these injections, but it has been found necessary, on the grounds of space alone, to reserve it for separate publication.

Intracavitary Treatment.

While intrapulmonary injections of G.A.C.C. "B" may play a big part in the detoxication of an area, or in the inhibition of lymph flow in affected tissues, apart from its particular effect on the parenchyma (*e.g.*, hyalinisation, etc.), yet if the treatment does not directly affect any existing cavity it will secure only a limited result, and a successful issue will be delayed.

In an excellent article on the mechanics and biology of tuberculous cavities Coryllos states:

"It is generally agreed today that tuberculous cavities represent the most important feature of pulmonary tuberculosis.

"They are not a mere complication of this disease, or only an interesting pathological characteristic; they are the disease itself. . . . In fact, they are the laboratories in which the tubercle bacillus lives and grows, and its metabolic products develop, causing both local and general symptoms of phthisis. Chronic pulmonary tuberculosis without cavities is a quiescent and benign disease; with cavities it is a progressive and malignant one."

He brings forward and emphasises the fact that cavities depend on their bronchial outlet for their maintenance. For example, he shows that a cavity with a patent draining bronchus remains, or increases in size, due to progressive disease, and disseminates tubercle bacilli. If, on the other hand, the bronchial outlet becomes obstructed, then the cavity will regress because of the loss of air pressure, and also the remaining gas will be absorbed, leaving the tubercle bacilli in the cavity under conditions of

anoxemia; and as human tubercle bacilli are strict aerobes, they are involved to their detriment.

Both anoxemia and obstruction of a draining bronchus should be readily obtained by intracavitary injections of G.A.C.C. " B," a heavy, sluggish medium which was specially prepared for that purpose. In the case of a large cavity directly connected with a lobar bronchus, however, one could only hope to effect a sterilisation or hyalinisation of the cavity walls themselves by leaving a thick gummy coating of the medium on the diseased surface.

Pagel and Robinson and others have recently drawn attention to cases presenting spontaneous healing of the cavity wall, rather than disappearance of the pathological space.

The difficulty of gaining access to cavities has been underrated, but if in a series of four intrapulmonary injections two, or even one, are intracavitary, successful results may be expected, for the cavity wall will be bathed in the antiseptic and hyalinising medium at body temperature for a lengthy continuous period, or until such time as it is absorbed into the diseased cavity wall or is drained away.

Moreover, X-rays may sometimes fail to show a cavity in the first place, or may show only one cavity, which on examination by the tomograph reveals a series in chain formation (McDougall). In this case the clinical result of the injection would be obscured. For example, Pagel and Robinson observe that: " In spite of healing of one cavity and marked fibrosis, another may remain infectious, and become the cause of amyloidosis or pulmonary hæmorrhage."

Conclusions.

Intrapulmonary injection of G.A.C.C. " B " in the human is a safe and rational method for the treatment of pulmonary tuberculosis in any of its stages, provided that the simple precautions laid down are observed.

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INCIDENCE OF TUBERCULOSIS IN YOUNG ADULT WOMEN, WITH SPECIAL REFERENCE TO EMPLOYMENT

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Paper read at the Annual Meeting of the Tuberculosis Association of Great Britain, at Oxford, April 7, 1938.

The matter on which I have been requested to speak to this meeting to-day —the incidence of tuberculosis among young adult women, with special reference to employment—may be tackled in different ways. I have chosen the simplest, which is first to examine young girls, and then to follow them up methodically through adolescence and the first adult years, under ordinary conditions of living, and then to examine young women before they take up a certain surveyable occupation—nursing—and to observe how the tuberculosis occurs in these two groups, under ordinary conditions of living for the first-named, and during nursing for the latter. This means, it is true, that I shall give information only regarding the effect of the tuberculosis among young women of one single occupation. In return, however, the information gained appears to supply knowledge of the conditions on which tuberculosis occurs also in other employment.

The first object with regard to the material is to know its relationship to tuberculosis at the time when it enters into the investigations. As the investigations include *future* tuberculosis only, we cannot use individuals who already have a tuberculous lesion, and concerning the others, the healthy individuals, we have to know who have been already infected by tuberculosis, the tuberculin positive, and who are still uninfected, the tuberculin negative. As this question—the tuberculin reaction of the individual—has proved to be of decisive importance to its future tuberculosis risk, I would like to mention the tuberculin test quite briefly.

In the present material this test has been carried out according to von Pirquet's specifications, with the only modification that the tuberculin has been slit into the epidermis instead of being drilled in. Two strips of approximately one and a half centimetre of concentrated old tuberculin, equal parts of human and bovine, are placed across the arm, and correspondingly long slits are made in these. In this manner the reaction due to the mechanical irritation, which occurred so frequently when the drilling

method was used, is avoided. The reaction is clear, specific. The reading is done after forty-eight to seventy-two hours, and if the reaction is doubtful or negative, the test is repeated. The reliability of this reaction, as compared with 1 milligramme tuberculin injected intracutaneously according to the Hamburger-Mantoux method, is that the Pirquet fails in 3·5 per cent. in which Hamburger-Mantoux gives reaction. I cannot here go into closer detail regarding the Pirquet reaction and its reliability, but would refer to previous publications on this subject, as also to the results which shall be reported here and the information that they furnish.

The investigations were commenced in 1924, and soon disclosed a fact which was very remarkable at that time: that at the age of about twenty years hardly one-half of the young women from the middle classes, from

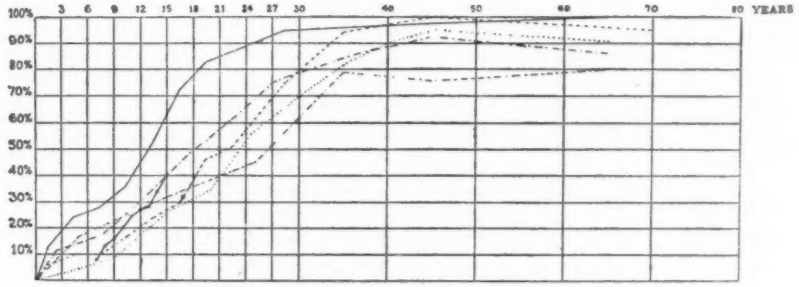

FIG. 1.—TUBERCULOUS INFECTION IN NORWAY.

——— = Oslo workers (labourers).
- - - - - = Oslo middle class.
—·—·— = Trondheim.
—·—·—·— = Trysil
..... = Tolga } rural districts.
—·—·— = Sollia

which the nurses are recruited, was tuberculin positive, and as to the young girls at the age of about fifteen years, only about one-third was infected with tuberculosis. As this fact was in opposition to the ruling opinion of general tuberculous infection in childhood, it had to be controlled by investigations into the tuberculous infection in all ages and classes in Norway, and the result of these investigations appears from Fig. 1.

The quickest spread through the age groups is found in the working classes of Oslo, where there are 45 per cent. infected, Pirquet positive, as early as at the age of twelve years, 84 per cent. at twenty-one years, and between 95 and 100 per cent. over thirty years of age. There are far fewer infected individuals, particularly in younger years, in all other groups of inhabitants: the ordinary citizen, the middle class of Oslo, the total population of Trondheim, and the rural population of different districts.

There are from 26 to 40 per cent. infected individuals at the age of fifteen years, and from 40 to 58 per cent. at the age of twenty-one years. The material included in our investigations—young girls, young women at the age of between fifteen to twenty years—will consequently consist of a larger number of tuberculin negative and a smaller number of tuberculin positive, as it is only the working classes in larger cities of which the majority is infected with tuberculosis at such a young age.

Many of my audience are now likely to think that these are conditions peculiar to Norway, and that conditions in other parts of the world, and

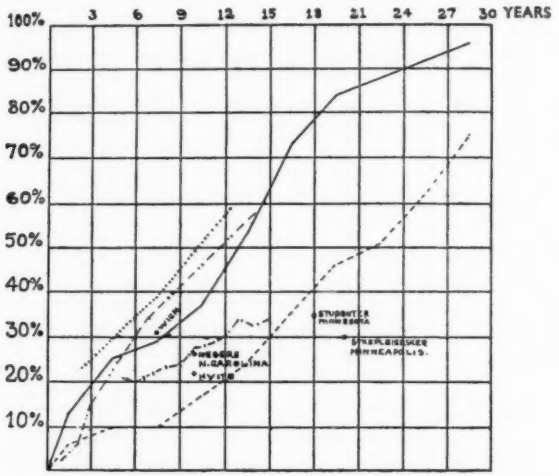

FIG. 2.—TUBERCULOUS INFECTION IN DIFFERENT COUNTRIES.

——— = Oslo labourers.
- - - - - = Oslo middle class.
..... = London labourers.
—·—·— = Helsingfors.
—|—|— = Massachusetts.

particularly, perhaps, in Great Britain, are totally different in that the great majority of individuals are infected by tuberculosis before adult age.

The above figure (Fig. 2), however, will demonstrate that investigations in other countries indicate that the spread of tuberculous infection in Norway is no exception to the general conditions.

Here we observe, as in the previous figure, the infection curves for the working class of Oslo, those which denoted the greatest spread, and the bourgeois class, which gave the chief line of the other infection curves. The London investigations from the Brompton Hospital show that the London children lie barely 10 per cent. above the Oslo children of the working class at the same age. Further, the investigations from the Vienna primary

schools, comprising more than one hundred thousand children at the age of seven years, show 31 per cent. infected, which is practically speaking the same figure as for Oslo children of the working class. The children of Helsingfors (Finland) also have approximately the same infection curve. The children of Massachusetts and Carolina also show the identical conditions, and American undergraduates at the age of eighteen years, and nurses at the age of twenty years, have considerably fewer infected individuals even than the bourgeois classes of Oslo.

With this knowledge of the state of tuberculous infection—that is to say of the spread of the tuberculin allergy—we shall observe the relationship of the young women to the tuberculous diseases, first under ordinary conditions such as life offers, and then during the work of nursing.

Our material of young women under general conditions of infection consists of two groups, all previously not suffering from tuberculosis, and all from Oslo. The first group consists of 1,458 individuals aged between thirteen and twenty-four years, who have been examined to find a general expression for the state of infection and morbidity from puberty up to adult age. The second group, age twenty to thirty, is included in order to obtain an exactly identical age group for comparison with the nurses.

Of the age group thirteen to twenty-four years, 467 were Pirquet positive, and 991 Pirquet negative, at the commencement of the period of observation.

The 467 Pirquet positive have a total of 2,111 years of observation—*i.e.*, number of years under observation, or until disease occurs. This gives an average of slightly more than four years of observation per individual. In the course of the observation period fourteen cases of tuberculous lesions have occurred among them, with one death. When the percentage of morbidity is to be calculated, this cannot, of course, be carried out on the number of individuals observed, as the separate individual observed cannot be correctly evaluated except when expressed through the number of years it has been under observation. The morbidity, therefore, should be calculated on the total number of years under observation—thus fourteen diseased in 2,111 years of observation, which works out at 6·6 per thousand years of observation. The objection may be raised here, that so small figures as 467 individuals in a total of 2,111 years of observation do not allow of any calculation of the average morbidity. In order to control the figure, therefore, I have made the same calculation for young men under identical conditions. The material in this case consists of 447 individuals with 1,831 years of observation and ten diseased, two of whom died. This works out at 5·5 diseased per thousand years of observation, a figure which strongly corroborates the result found for women—6·6 *diseased per thousand years of observation—and this figure constitutes the first result in our investigations.*

TABLE I.

TUBERCULOSIS AMONG WOMEN.

	Number.	*Years Observed.*	*Diseased.*	*Dead.*	*Per Thousand Years.*		*Morbidity. (Annual Percentage.)*
					Infected.	*Diseased.*	
Aged 13 to 24 years:							
Pirquet positive ..	467	2,111	14	1	1,000	6·6	0·6
Pirquet negative ..	991	4,697	52	3	45·6	11·1	23·0
Infected	226						
Aged 20 to 30 years:							
Pirquet positive ..	403	1,364	6	2	1,000	4·4	0·4
Pirquet negative ..	279	871	20	3	83·7	23·0	28·5
Infected	73						

Of Pirquet negative we have 991 individuals with a total of 4,697 years of observation. In the course of this period fifty-two cases have occurred of tuberculous diseases, with three deaths. These figures at once inform us of the fact that the tuberculous morbidity is much higher according to the primary infection than according to the super infections. If the morbidity here among the negative is calculated directly on the years of observation, we get the figure of eleven diseased per thousand years of observation, which is about double the figure found among the positive. This figure, however, eleven per thousand years of observation, does not give a correct expression of the morbidity in primary infection. We know, as a matter of fact, from the previously demonstrated figures, that only a minority undergoes a primary infection in the course of averagely four years, the period of observation at the age of thirteen to twenty-four. In order to find the percentage of morbidity of the primary infection, we first have to ascertain how many of our tuberculin negative individuals have become infected during the period of observation.

Of the 991 young women who have been under observation, 399 have been examined in person during the observation period and at its close. They have a total of 2,304 years of observation, during which period eighty have become infected, Pirquet positive, without becoming diseased. If we assume—and this appears to be correct—that the fifty-two diseased among our negative individuals are fairly evenly distributed in the material, twenty-five of these diseased individuals should be added to the eighty who were found to be infected when examined in person. The result obtained in this way is, that in the course of 2,304 years of observation 105 individuals have become infected, which makes 45·6 per thousand years of observation, or 226 individuals infected during our period of observation

of 4,967 years. Fifty-two of these 226 infected individuals have become diseased, and three have died.

If in order to control these findings the identical investigation is carried out in men of the same age and in the same conditions of living, the figures are 884 individuals with 3,680 years of observation, and thirty-seven diseased of whom four have died. The infection calculated on the basis of personal examinations is 58·7 per thousand years of observation, which works out at 216 infected individuals in the total material, of whom thirty-seven have become diseased and four have died.

Expressed quite simply, this means: Under ordinary conditions of infection and living, in a middle-sized town, among women of the age of thirteen to twenty-four years—

Approximately six previously healthy and infected individuals per thousand years of observation will become diseased with some form of tuberculosis with causal relation in the old, latent primary infection, or subsequent super infections.

Forty-five previously uninfected individuals per thousand years of observation will become infected, and eleven of these—one-fourth—will become diseased. Consequently the primary infection has a morbidity of approximately 25 per cent.

In the second group, women aged twenty to thirty years, the state of infection and morbidity is calculated in the same manner (see Table I).

There are 403 Pirquet positive with a total of 1,364 years of observation, in the course of which six have become diseased, and two have died. This works out at a morbidity of 4·4 per thousand years of observation.

There are 279 Pirquet negative with 871 years of observation. In the course of the period of observation seventy-three have become infected, twenty of whom have become diseased, and three have died. This gives an infection of 83·7 and a morbidity of twenty-three per thousand years of observation.

We thus observe that the incidence of infection increases from the age before twenty years to the age after twenty years from forty-five to eighty-three per thousand, and in consequence, of course, the number of diseased per thousand increases. It is not only the actual number of diseased which increases, however, but also the relative number, the morbidity, which increases from 23 to 28 per cent. This applies to the direct effect of the primary infection. The effect of the old, latent primary infection and superinfections, on the other hand, is uniform in both groups—four to six per thousand years of observation.

The following table (Table II.) gives a list of the diagnoses for women with tuberculous lesions in these groups.

TABLE II.

TUBERCULOUS DISEASES AMONG WOMEN AGED 13 TO 24 YEARS.

	Pirquet Positive.	*Pirquet Negative.*
Glandular tuberculosis	1	4
Erythema nodosum	—	16
Erythema nodosum. Pleurisy	—	1
Erythema nodosum. Meningitis	—	1 (dead)
Erythema nodosum. Pulmonary tuberculosis	—	1
Pleurisy	1	15
Pleurisy. Pulmonary infiltration	—	1
Tuberculosis of the knee	—	1
Pulmonary infiltration	2	4
Pulmonary tuberculosis	10 (1 dead)	8 (2 dead)
	14	52

TUBERCULOUS DISEASES AMONG WOMEN AGED 20 TO 30 YEARS.

	Pirquet Positive.	*Pirquet Negative.*
Erythema nodosum	—	6
Pleurisy	—	5
Pleurisy. Pulmonary tuberculosis	—	1
Pulmonary infiltration	1	4
Pulmonary tuberculosis	5 (2 dead)	4 (3 dead)
	6	20

We shall now proceed to the investigations of tuberculous diseases among nurses carried out at the Municipal Hospital of Oslo, Ulleval. This is a general hospital with a full range of special departments. Tuberculous patients, however, are treated not only at the special tuberculosis sanatorium, but also at the Department of Internal Medicine and at the Surgical Departments, as also occasionally at the other departments. In the various departments with their 2,600 beds are treated at all times a total of approximately 400 patients with tuberculous lesions, chiefly with open pulmonary tuberculosis. One understands from this that there is ample tuberculous infection.

The hospital has a three-year training school for nurses, to which are admitted healthy women of approximately twenty years of age. Their training consists of some theoretical tuition, but chiefly of practical work at the various departments. Between 110 to 120 probationers are admitted each year. On admission, therefore, the probationers constitute as far as possible a uniform material of healthy women of the same age. During the three years of training they all live at the hospital, either in the large Nurses' Home, or at the separate departments, and eat the same food, have the same hours of work and the same vacations. Their life during the

three years of training, therefore, is as uniform as possible with regard to work as well as to the conditions of living generally, and particularly with regard to tuberculous infection, to which they are amply exposed. After the three years of training the conditions become less uniform, as the graduated nurses are then partly attached to the separate departments where the conditions of infection may vary, and partly they secure work outside the hospital.

During the years 1924 to 1936, the years covered by the investigations, 1,453 probationers entered training school. 668 of these were Pirquet positive, that is 45·3 per cent., and 785 were Pirquet negative, that is 54·7 per cent. These figures correspond fairly accurately with those which might be expected when considering the investigations reported previously, in which the percentage of infection in the rural and middle classes, from which the nurses are recruited, lay between 40 and 50 per cent.

The percentage of infection in the different year classes varied between 53 as the highest and 34 as the lowest. The year of the lowest percentage of infection the Pirquet test was controlled and corrected with one milligramme tuberculin intracutaneously, as carried out in the three last year classes.

With regard to the fate of these young women after they have commenced work at the hospital and are exposed to infection from tuberculous patients, the first remarkable fact is that those who initially were Pirquet negative rapidly become positive. Control of their allergy at brief intervals reveals that the majority become positive two to three months after they start nursing tuberculous patients, and in the course of the three years' training all have become infected, which fact immediately offers proof of the exceedingly ample tuberculous infection, as during nursing the number of infected individuals increases from under 50 to 100 per cent. in the course of three years, an increase which it takes twenty years to reach in the middle class with other work, or is not reached at all as shown by the infection curves from Norway previously demonstrated, in which 100 per cent. infected individuals was reached at the age of forty to fifty years, or never. As compared with the investigations just mentioned, in which the figure of infection was forty to fifty per thousand years of observation, which is 5-6 per cent. annually, we find among the nurses 100 per cent. per three years.

How then is the state of the tuberculous lesions among the nurses? As mentioned, the observations comprise all age groups from 1924 to 1936 inclusive, and they have been carried on continuously until now. The longest period of observation, therefore, has been accorded to the year 1924 with fourteen years of observation, and the shortest period of observation has the year 1936 with two years only.

In 1924, 109 probationers commenced training, fifty-eight of whom were Pirquet positive and fifty-one Pirquet negative. In the course of the first half-year at the hospital five of the negative contracted some tuberculous disease or other, in the course of the second half-year four, in the course of the third half-year one, in the course of the fourth half-year four, in the fifth one, in the sixth one—all from among the fifty-one who were not infected with tuberculosis when they commenced, and who, as mentioned before, had now all become infected. Among the fifty-eight who were, when they commenced the work of nursing, just as healthy as the uninfected, but were infected, Pirquet positive, no single case of tuberculous disease had occurred in the time mentioned. Subsequently, in the ninth half-year, one further case has occurred among the initially Pirquet negative, and also one case among the initially positive. The total result in this year is, that after fourteen years of observation eighteen cases of tuberculous lesions have occurred among the fifty-one initially negative, and one case among the fifty-eight initially positive. For the present I shall not touch upon the nature of these lesions. I would only like to state that of the eighteen diseased among the previously negative seven have died from their tuberculosis.

The following year groups also demonstrate the same relationship as the year group 1924—overwhelming tuberculous morbidity among the Pirquet negative, and comparatively low among the initially Pirquet positive.

In 1925 forty-two Pirquet positive commenced training, among whom one has gradually become diseased, while there have been twenty-six diseased among the seventy-two initially negative. In the year 1926 one is diseased among the fifty-two positive as against eighteen among the sixty-two negative.

From 1927 the table becomes somewhat changed, as we have added to the previous columns, Pirquet positive and Pirquet negative, another column, BCG, for each year. I would request my audience to disregard this group, which consists of Pirquet negative individuals who have been vaccinated with BCG, and to study only the earlier groups: the Pirquet positive and the Pirquet negative. In the year group 1927 are four diseased among sixty-four Pirquet positive as against eleven among nineteen Pirquet negative, and so forth. In 1932, for example, there were two diseased among forty-two Pirquet positive as against five among thirteen Pirquet negative —always the same relation, high morbidity among the initially Pirquet negative, low among the initially positive. The final result is that there have been thirty-four cases of tuberculous lesions, and no deaths, among 668 Pirquet positive, while among 284 initially Pirquet negative, as they

have gradually become infected, 104 have contracted tuberculosis, and thirteen have died from their lesion.

This result is so striking, with such an enormous difference in morbidity between the two groups, that it would no doubt have been justifiable to draw conclusions already at this juncture. Before doing this, however, we shall go into the material somewhat more in detail. We shall then first look at the list of diagnoses.

The tuberculous lesions are recorded in this table reasonably according to malignancy, so that the least malignant appear at the top and then gradually downwards the more malignant forms.

TABLE III.

TUBERCULOUS DISEASES AMONG NURSES.

	Pirquet Positive.	*Pirquet Negative.*	
Tuberculosis of the bronchial glands	—	3	
Tuberculosis of the throat glands	1	—	
Erythema nodosum	2	22	
Erythema nodosum. Tuberculosis of the throat glands	—	1	
Erythema nodosum. Pleurisy	1	3	
Erythema nodosum. Pulmonary infiltration	3	10	
Erythema nodosum. Pulmonary infiltration. Pleurisy	—	2	
Erythema nodosum. Pleurisy. Tuberculous peritonitis	—	2	
Erythema nodosum. Bone tuberculosis	—	1	
Erythema nodosum. Pulmonary tuberculosis.	—	4	(2 dead)
Pleurisy	6	9	
Pleurisy. Pulmonary infiltration.	2	10	
Pleurisy. Renal tuberculosis	—	1	
Pleurisy. Pulmonary tuberculosis	—	3	(1 dead)
Tuberculous peritonitis	1	—	
Pulmonary infiltration	2	15	
Pulmonary infiltration. Caries costæ	—	1	
Tuberculous meningitis	—	2	(2 dead)
Miliary tuberculosis	—	1	(1 dead)
Pulmonary tuberculosis	16	14	(7 dead)
Total	34	104	(13 dead)
Benignant forms:			
Glandular tuberculosis. Erythema nodosum. Pleurisy. Pulmonary infiltration.	17	75	
Malignant forms:			
Bone tuberculosis. Renal tuberculosis. Peritonitis. Pulmonary tuberculosis. Miliary tuberculosis. Meningitis.	17	29	(13 dead)

First I would like to remark that all diseased among the Pirquet negative, at the time when they contracted the disease, had recently become, or then became, tuberculin positive.

First comes tuberculosis of the bronchial glands, with three cases among the negative. Then tuberculosis of the throat glands, with one case among the positive. Next comes the large group of erythema nodosum. There are two clear cases of erythema nodosum among the Pirquet positive, twenty-two among the Pirquet negative. Next we have the groups of erythema nodosum associated with or followed by other tuberculous lesions: glandular tuberculosis, pleurisy, peritonitis, bone tuberculosis, pulmonary infiltration with no signs of destruction—bacilli—cavitation, and finally, development into the destructive pulmonary tuberculosis. The total figure here is four among the Pirquet positive, and twenty-three among the Pirquet negative. Of these latter two deaths. Then we have the pleurisies —first the clear cases, without other tuberculous lesions, six among the positive and nine among the negative. Next pleurisy associated with other varieties of tuberculosis, two among the positive and fourteen among the negative, one of whom died.

Then comes tuberculous peritonitis, one among the positive, and then the tuberculous pulmonary infiltration without destruction: two among the positive and fifteen among the negative. Finally meningitis, two among the negative—both died. One case of miliary tuberculosis, also among the negative, and lastly the phthisis: sixteen among the positive and fourteen, of which seven deaths, among the negative.

The subject does not permit of further discussion with regard to the case histories. It may be that some will claim—even if this, in my opinion, is unjustified—that when the incidence of tuberculosis within a certain occupation is being discussed, it is only the malignant or chronic forms which should be concerned. So as not to occasion such criticism of the material, therefore, we shall exclude all non-chronic, non-malignant tuberculous lesions, and shall retain only the actual pulmonary tuberculosis, bone tuberculosis, peritonitis, miliary tuberculosis and meningitis. Seventeen of these are among the Pirquet positive with no deaths, as against twenty-nine among the 284 Pirquet negative with thirteen deaths. It will thus be seen that even this method of calculation presents a morbidity among the Pirquet negative which is approximately four times that among the Pirquet positive, and the mortality cannot be compared at all.

Further, it may be noticed that the material, as previously indicated, falls into two groups as far as the period of observation is concerned—viz., the three years as probationers with definite ample infection, and the subsequent period with variable and partly very small chances of infection.

TABLE IV.

	Number.	*Years Observed.*	*Diseased.*	*Dead.*	*Per Thousand Years.*		*Morbidity. (Annual Percentage.)*
					Infected.	*Diseased.*	
Probationer Nurses:							
Pirquet positive ..	668	1,772	22	0	1,000	12·3	1·2
Pirquet negative ..	284	687	97	12	413	126 6	34·3
Infected ..	284						
Graduated Nurses:							
Pirquet positive ..	504	2,946	12	0	1,000	4·1	0·4
Pirquet positive .. (initially negative)	178	1,361	7	1	1,000	5·1	0·5

In the first period, the probationer time, we find 668 Pirquet positive who have a total of 1,772 years of observation and twenty-two diseased. As mentioned before, this works out at 12·3 diseased per 1,000 years of observation.

We have 284 Pirquet negative in this first period with 687 years of observation and ninety-seven diseased, of whom twelve deaths. Calculated as before, this works out at 413 infected per thousand years of observation, and of the 284 infected here, the total material, about one-third—which is 34·2 per cent.—have contracted tuberculosis, and twelve have died.

In the second period 504 of the initially Pirquet positive with 2,946 years of observation have twelve diseased, which works out at 4·1 diseased individuals per thousand years of observation. There remain in this period 178 of the initially Pirquet negative with a total of 1,361 years of observation, seven diseased and one death. It should be noted with regard to these individuals that they were all infected at the beginning of the period of observation, as mentioned previously, and all were healthy. Their morbidity, therefore, may be calculated in the same manner as for the preceding group, direct, and we then find 5·1 diseased individuals per thousand years of observation.

Now the material has been presented, and it remains to draw conclusions from it.

The first thing to be remarked is the tuberculous morbidity amongst women aged from thirteen to twenty-four years, under ordinary conditions of living. The annual conditions here are as follows: Fresh infections occur in 4 to 5 per cent. and of these 23 per cent. become diseased due to their primary infection. Of those who have gone through the primary infection without becoming diseased, only 0·6 per cent. annually contract tuberculosis.

In the age group twenty to thirty years there seem to occur compara-

tively more primary infections—8·3 per cent.—and the morbidity also seems to be higher than in the previous years—28·5 per cent. The women who enter this age group without having become diseased with their previous primary infection—*i.e.*, Pirquet positive and healthy individuals—have the same morbidity as in previous years, approximately one-half per cent.

In the work of nursing tuberculous patients the infection risk is exceedingly great. Of the initially uninfected 41·3 per cent. annually contract primary infection here, which is five times as many as under ordinary conditions. Of these 34·3 per cent. become diseased with tuberculosis. Among those who are Pirquet positive and healthy, after their primary infection, and then enter the violent infection to which they are exposed in nursing work, the percentage of morbidity is 1·2, which is the double of that found among women under ordinary conditions of living, of the same age.

The conclusion to be drawn from this material must be: The tuberculosis risk attached to the work of nursing chiefly depends on two factors. The first and dominant is, whether the women who enter such work are allergic without having contracted tuberculosis, as these individuals have an exceedingly great resistance immunity against subsequent exogenous tuberculous infection. This fact may be clearly observed in the three groups in which we have positive as well as negative individuals. The other factor is the extent of the tuberculous infection to which they are exposed. If it is ample it will increase the incidence of infection manifold, thus also increasing the actual number of individuals who have contracted tuberculosis. But it is not only the actual tuberculous morbidity which is increased when the individuals are exposed to such violent infection, but also the relative morbidity, as the percentage of morbidity among those with primary infection is increased from 28 to 34 per cent., and among the previously infected, who may have been superinfected, from 0·4 to 1·2 per cent. When the tuberculous infection is not greater in nursing work than under other conditions, as in the group Graduated Nurses, the tuberculous morbidity is not higher either. It seems reasonable to assume that the chief factors mentioned here, which have an influence on the tuberculous morbidity in the work of nursing, the individual resistance, immunity, as expressed by allergy in healthy persons, and the exogenous infection, are also the decisive factors with regard to the incidence of tuberculous morbidity in other employments.

PULMONARY TUBERCULOSIS IN WOMEN WORKERS*

By SIR HENRY H. BASHFORD,
M.D., M.R.C.P.(LOND.),
Chief Medical Officer to the Post Office, London.

The following experience of the incidence and after-history of pulmonary tuberculosis among women workers relates to the established pensionable staff of the Post Office and should perhaps be prefaced by some general brief remarks. This staff at the present moment consists of about 125,000 men and 37,000 women. Excluding the engineering staffs, about 25 per cent. of these men are fifty years of age and over, and include a considerable number suffering from war disabilities. About 23 per cent. of the women are forty years of age or over. The men include postmen, sorters, porters, telegraphists, engineers, and of course large groups engaged on clerical, accounting, and administrative duties. The women include telephonists, telegraphists, and various sorts of clerical workers.

Regarding it as an industry, the Post Office is therefore a very various one, and, numerically speaking, it is the largest, if its unestablished and probationary workers are included, in this country. It differs, however, in some respects from most outside industries in that the great majority of its employees are established, pensionable civil servants, who have passed one and sometimes two very careful medical examinations before entrance, and who are entitled, so long as there is a reasonable prospect of recovery to render regular and efficient service in future, to full pay during sick absence for six months, half-pay for six months, and pay at pension rate thereafter, if this has been qualified for.

Further, all established Post Office employees with a salary of less, roughly speaking, than £5 a week are entitled to free medical attention of a good general practitioner standard. Outside headquarters this service is given by general medical practitioners who hold the local Post Office appointment. In addition they examine all local candidates for the service, keep an eye on the ventilation and sanitation of the offices and telephone exchanges under their care, advise local head postmasters and controlling officers on local medical questions, and furnish an annual report on the health of the staff to the chief medical officer.

There are some 2,600 of these local Post Office medical officers in

* A Paper read at the Oxford Meeting of the Tuberculosis Association in April.

England, Scotland, Wales, and North Ireland, and the service is administered by a small Headquarters Medical Branch, consisting of a chief medical officer, a second medical officer, a senior woman medical officer, and nine assistant men and women medical officers, the latter of whom give clinical attention to the large headquarters staffs in London amounting to about 25,000.

The Post Office, whose industrial medical service dates back to the middle of the last century, is also unique in that it possesses accurate sick records of all its employees—a total of about 260,000—from the ages of sixteen to sixty, and in many cases from fourteen to sixty. And it will be appreciated that such records make feasible certain researches that would scarcely, on so large a scale and over so long a period, be possible elsewhere. The results in terms of everyday working capacity of various abnormalities, lesions, and complaints, and the results of various forms of medical and surgical treatment can be observed with an accuracy that would not be within the scope of the most careful follow-up department of a hospital or individual surgeon or physician.

This is also true, I think, from this particular aspect, in the case of pulmonary tuberculosis. Whenever a case is reported either amongst those of the staff entitled to free medical attendance or the others, a medical report is completed either by the local Post Office medical officer or the private medical attendant, as the case may be, and all cases are registered at headquarters. Intermediate reports are obtained at intervals, and before resumption of duty is allowed, each case must be seen by the relative local Post Office medical officer or one of the headquarters medical staff and a final report completed.

So much for the general mechanism, and turning to the incidence of pulmonary tuberculosis as we have encountered it in the Post Office, it may be said, considering that all Post Office employees are within what may be called the pulmonary tuberculosis period of life, that it compares very favourably with that in the community at large, and it has shown a steadily downward trend during the last twenty years, the incidence rate for 1935 being the lowest of which we have any record. Actually for the years 1931 to 1935 inclusive the incidence rate for the whole established staff was 1·48 per 1,000, as compared with 1·15 per 1,000 of notified cases in the general population of England and Wales, which of course includes large numbers of persons under fourteen and over sixty, when pulmonary tuberculosis is relatively rare.

In so large a staff, however, a good many cases must be expected to occur, and we were recently able to publish (*Lancet*, November 7, 1936) an analysis of the after-history of 3,755 cases, all of which we were able to

follow up for a period of not less than ten years and up to twenty-two years. Summarised briefly—and although the Post Office is willing to allow very prolonged sick absence in such cases if there seems a reasonable prospect of recovery—it has been our constant experience that 50 per cent. of all new cases are never able to return to work at all. Of the 50 per cent. who do return—and although every effort is made to find suitable duties for them—there has been a constant wastage of 48 per cent., either for recurrent pulmonary tuberculosis or other forms of ill-health, by the end of ten years. After that the prospects grow better, and in the following five years the wastage has been reduced to 14 per cent.

We have also found that, both as regards incidence and industrial survival, light manual and clerical indoor workers have a slight advantage over manual, mainly outdoor workers; and as regards incidence between the sexes over the years 1920 to 1935 inclusive, we have found the incidence rate to be slightly lower amongst women than men—namely, 1·24 per 1,000, as compared with 1·54 per 1,000.

Turning to the particular problem of pulmonary tuberculosis amongst women, the Post Office experience is probably the same as that of most outside industries—they are, industrially speaking, a much less stable population than the men. There are large numbers of resignations for marriage, domestic, and other reasons; and the follow-up of cases of pulmonary tuberculosis is therefore considerably less accurate. For what it is worth, however, we have found that out of 231 cases returning to work as cured or arrested in the years 1914 to 1926 inclusive, 65 had either died or been retired owing to recurrence of pulmonary tuberculosis and 17 owing to other forms of ill-health within ten years of such return, 82 being still at work at the end of that period.

Finally, as regards incidence in age groups, a recent research has enabled us to state this with considerable accuracy for the years 1932, 1933, and 1934. During that time we had approximately 3,500 women under 20, 15,000 between 20 and 30, 7,000 between 30 and 40, and 8,000 over 40. The average incidence for those years in the under 20 group was 0·76 per 1,000; in the 20 to 30 group, 1·49 per 1,000; in the 30 to 40 group, 0·76 per 1,000; and in the over 40 group, 0·33 per 1,000. It will thus be seen that the heaviest incidence, by nearly 50 per cent., was between the ages of 20 to 30.

THE INCIDENCE OF TUBERCULOSIS IN YOUNG ADULT WOMEN

By C. J. CAMPBELL FAILL,
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THE problem of acute phthisis in young adults, more particularly females, has been attracting more attention for the last few years among both administrators and clinicians.

It is of interest to the administrator because, unlike the other forms of pulmonary tuberculosis, it actually shows an increase, and it is of interest to the clinician because it appears to differ in every way from classical phthisis. The differences are so great that indeed it might almost be a different disease, caused by a totally different organism.

Bristol in pre-war days had a great deal more acute young adult phthisis than is usually found in a large city. This was attributed to its close connection with Wales, where this type of tubercle is prevalent. As a result of this I fancy our increase of recent years has probably been less than many other places.

In Bristol in the census years 1911, 1921, and 1931 the death-rate of females between the ages of 15 and 25 per 100,000 living was 26·5 in 1911, 23 in 1921, and 24 in 1931.

I have only taken these census years because our population has fluctuated greatly with the rise of new industries and the extension of the city boundaries, so that the figures for other years are, in my opinion, quite unreliable for the purpose of this paper.

Although the increase is apparently small, an increase of one death per 100,000 living in that particular age group is very puzzling, when the death-rate in all other age groups is falling.

I am afraid that my paper is going to be quite inconstructive, because frankly I have no explanation or even suggestion to make as to the cause of this, but I think the coming of summer time should be borne in mind, with its lengthened hours of daylight, and therefore shortened period of rest to young persons, who are still growing, and who require a good deal more rest than they seem to think themselves.

For the purpose of this paper I have gone into the deaths from tuberculosis in the year 1937 among females from 15 to 25. I first divided them into two groups—15 to 20 and 20 to 25.

The 15 to 20 group numbered 17, and in 13 of these no family history of tubercle could be found, nor was any case of tubercle detected in any member of the family who consented to be examined. In 2 cases the mother suffered from pulmonary tuberculosis, and in 2 others either a brother or a sister.

With regard to occupation, only 4 worked in factories (1 in a boot factory, 1 in a tobacco factory, and 2 in printing factories). Of the rest, 2 were mental defectives, 4 were engaged in domestic work either at home or away, 2 worked in shops, 2 were waitresses, there was 1 office girl, 1 tailoress, and 1 barmaid.

The average duration of illness from the first symptoms till death was 12 months; this, however, includes one girl of 15, who spent 5 years in sanatorium, and another girl of 17 who spent just over 2 years in sanatorium. These two cases were the typical chronic classical phthisis, which, although rare, does occur at this age. If they were taken out, the average length of the illness of the remainder was only 7 months.

The initial symptoms were very varied indeed. In 3 cases the illness appeared to begin with an attack of influenza. In 5 others the first symptom noted was cough, and in 3 abdominal pain. In one case the onset was insidious. In one no history could be obtained, as the patient was almost moribund when first seen, and was living in lodgings. One commenced with pleurisy, one with hæmoptysis, and one with amenorrhœa.

It will be seen that the almost complete lack of family history is characteristic of acute tubercle in this age group, and that factory work could have very little to do with its causation. Of the 17, 12 worked at definitely unhealthy occupations, where the hours were long and the pay short.

In the group 20 to 25 there were 27 cases; of these, 11 worked in factories (5 in clothing factories, 1 in a chocolate factory, 1 in a boot factory, and 1 in a printing factory), 8 were married, and of these 2 were puerperal cases, 4 worked in offices, there was one school teacher and one domestic, one was a photographer's assistant, and one was a girl whose illness commenced at the age of 5 years with a tuberculous knee, and who died at the age of 25 years, having spent actually 20 years in sanatorium or hospital.

The average length of illness from the first symptom until death was 27 months; this, however, included the case which began with tuberculous knee at the age of 5 years, and who died at the age of 25 years. If this is taken out, the average duration of illness from the first symptom was 19 months.

As to the mode of onset in this group, only one case appeared to follow influenza, in 6 the first symptom was pleurisy, and in another 6 cough. In 7 the onset was slow and insidious; one commenced with hæmoptysis, one with pain in the back which turned out to be tuberculous spine, one tuberculous knee, and in one amenorrhœa was the first symptom noted;

there were 2 where no history could be obtained. The remaining case in this series to make up the 27 is of considerable interest. The patient was a school teacher aged 25 years who had no family history of tubercle, was admitted to hospital, and operated on for tuberculous glands of neck; she immediately developed acute pulmonary tubercle, and died in sanatorium in less than 5 months.

When the question of occupation is gone into some rather curious facts emerge. In the first place it must be remembered that a very large proportion of the females employed in the city of Bristol work in factories. The majority of our factories are probably the best in the whole world, but one would expect naturally that a certain number of cases of tubercle would develop among the large number employed.

Looking at the occupations of the group 15 to 20, only 4 of the 17 came from factories; these were the only 4 of the whole series whose occupations and surroundings could be described as satisfactory. All the rest were very definitely unsatisfactory. Of the 4 engaged in domestic work, 3 were overworked and under-paid general servants in shops in poor parts of the town, and the fourth was a little girl of 16 who was doing the whole work of the house while her mother was in sanatorium. The two shop assistants and the two waitresses all worked very long hours for small pay. The tailoress and the office girl worked under bad conditions, and the barmaid was found in a public-house in a slum.

The group 20 to 25 shows an absolutely different picture; they all with one possible exception worked under good conditions and in good surroundings. Of the 26, 11 worked in factories, and it is interesting to note that not one of the eleven came from a tobacco factory. The 4 engaged in office work were shorthand typists in good offices. The one domestic was in good-class service, where, though she may have had to work very hard, she certainly lived under good conditions, with an ample diet. The school teacher also lived under good conditions, with an adequate salary. The only one in this series that I have any doubt about in regard to employment was the photographer's assistant. The 8 married women were all reasonably comfortably off. Some had no children, and the largest family numbered two.

It is very striking the difference between these two groups, the younger group, 15 to 20, nearly all working and living under adverse conditions, and the larger group, 20 to 25, all living and working under relatively good conditions.

I can offer no explanation for this, and repeat I am very sorry I have nothing constructive to offer. I merely place before you a bald statement of what happened in the city of Bristol in 1937.

EXTRAPLEURAL PNEUMOTHORAX

VIEWS AND EXPERIENCES*

By R. C. BROCK,
M.S., F.R.C.S.,

Assistant Surgeon to Guy's Hospital, Assistant Surgeon to the Brompton Hospital, Thoracic Surgeon to the London County Council.

The surgical freeing of the apex of the lung by extrapleural dissection—so-called apicolysis—was first described by Tuffier in 1891, and in 1912 he made attempts to maintain an extrapleural pneumothorax in two cases without success. Although other attempts were also made by various other surgeons at different times, none of these was successful, and the method had been virtually abandoned as having no practical utility until the work of Graf of Dresden in 1935 and later of Schmidt of Heidelberg in 1936 caused it to be used again, this time with a vigour and enthusiasm which bear excellent witness to its efficacy. There is no doubt that the earlier attempts failed simply through poor technique; no real attempt was made to achieve that very perfect and concentric freeing of the whole of the upper part of the lung (pneumolysis rather than apicolysis) which is what we aim to do today.

The theoretical objections to the method are only too obvious, but all idle armchair speculation as to its certain failure has been triumphed over by the very successful practical demonstration that it can be satisfactorily carried out.

Technique of Operation.

This is not the time or place to give a detailed account of the technique of the actual operation and after-care, but a few remarks are necessary for the benefit of those unfamiliar with it, and also to draw attention to certain points which I consider are of fundamental importance.

Although for some patients general anæsthesia is desirable, in the vast majority the operation can be done quite easily and with certain great advantages entirely under local anæsthesia. I have now done some twenty-five consecutive cases in this way. While using general anæsthesia I had three patients who developed a spread of their disease after operation, and I decided that while the use of local anæsthesia would not entirely prevent

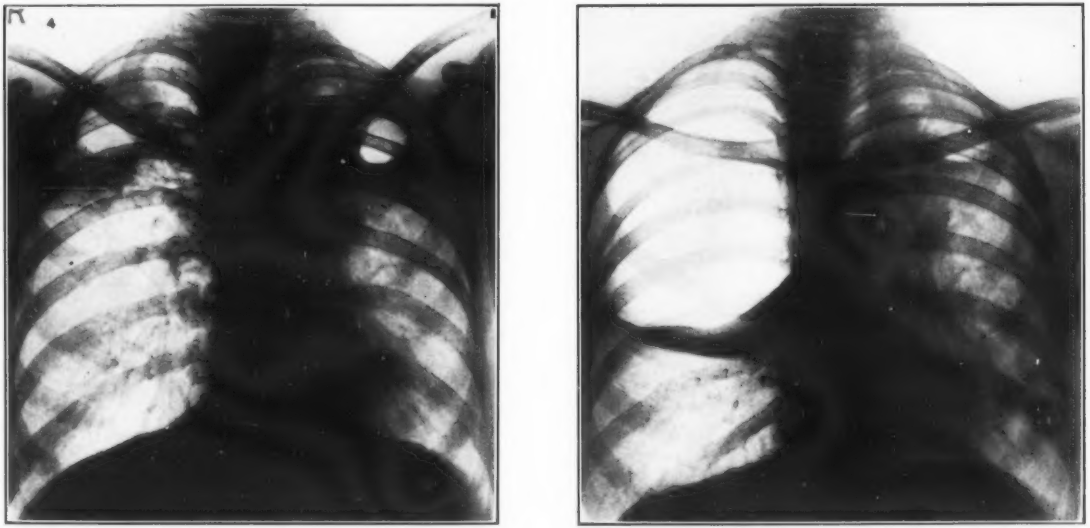
* A paper read at the Oxford meeting of the Tuberculosis Association in April.

this occurrence it should at any rate diminish the chance of it happening. In addition, local anæsthesia has certain other advantages, notably the small amount of bleeding and the minimum of general disturbance to the patient. I am not entirely convinced of the desirability of using local alone in every case, as I have been doing lately, but if care is taken to add general anæsthesia (cyclopropane) when the patient is at all apprehensive or in pain, then the operation can certainly be begun with it. Even after general anæsthesia it is remarkable how little upset the patient usually is by the operation, and it is common to see him sitting up in bed quite comfortable within a few hours. How mild can be the disturbance is shown by one of my patients on whom I did an extensive extrapleural strip for a pneumonic form of phthisis which was associated with constant pyrexia and toxæmia. Three hours later I went in to see him and found him quite happily eating his evening meal as if nothing had happened.

The posterior route is the best, because one has direct access to the region which is usually the most densely adherent. A short segment of one of the upper ribs is resected after making an incision of some 4 inches in length. Personally I feel the best rib to choose is the fourth. The third does not give quite such good access; on the other hand, the fifth is not too low, for I have used it several times in error and on one occasion went as low as the sixth. Once the rib bed has been exposed, the correct anatomical layer is found—that is, the immediate extrapleural zone. In the normal chest there is, below the extreme apex, an exceedingly delicate layer of areolar tissue between the pleura and the actual chest wall. In disease, as a result of peripleuritis, this becomes thickened so as to form a definite and well-marked fascial layer, which then deserves the name of endothoracic fascia. All stripping should be done between this layer and the parietal pleura, and the greatest care must be exercised to keep in this plane. Once it is lost and dissection followed in the extra-fascial plane, bleeding becomes troublesome or even dangerous. To keep in this layer it is essential to have proper illumination, a dry field, and to proceed with the greatest caution. I am convinced that the smoothness, and sometimes even the success, of the operation depends on doing this properly. Personally I prefer to use the finger as little as possible and to rely on careful direct instrumental dissection.

The next thing of importance is the extent of the strip. I believe one of the reasons for the earlier failures was the grossly inadequate strip that was employed. To obtain good results it is necessary to free the upper part of the lung to exactly the same extent as the lung is freed by an artificial pneumothorax in the absence of any adhesions. In other words, it must be separated not only from the lateral chest wall, but also from the apex and

PLATE XII

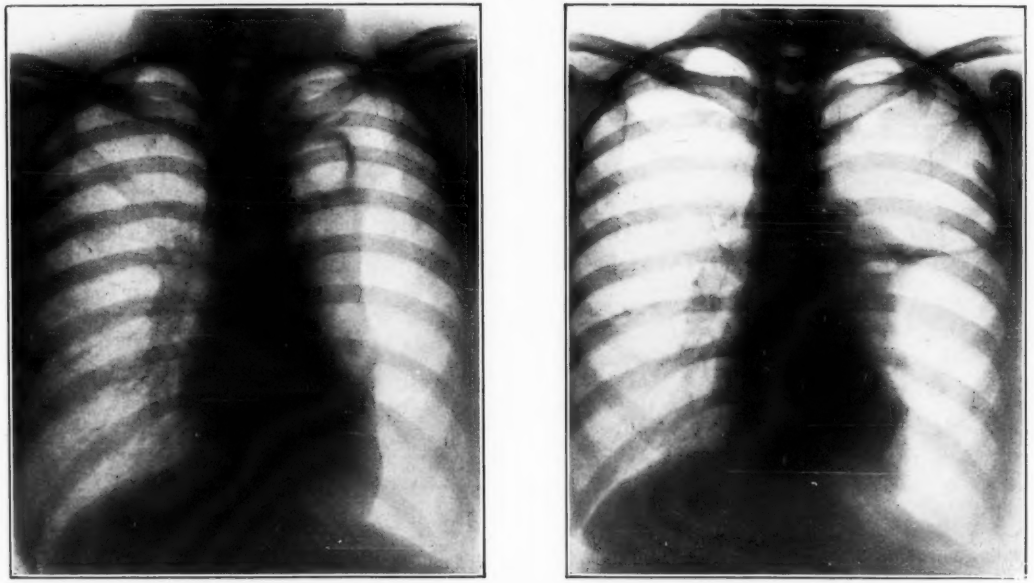


a *b*

FIG. 1.—BILATERAL CAVERNOUS PHTHISIS BEFORE AND AFTER EXTRAPLEURAL PNEUMOTHORAX.
A Semb thoracoplasty has since been done on the left side.

[To face page 174.

PLATE XIII

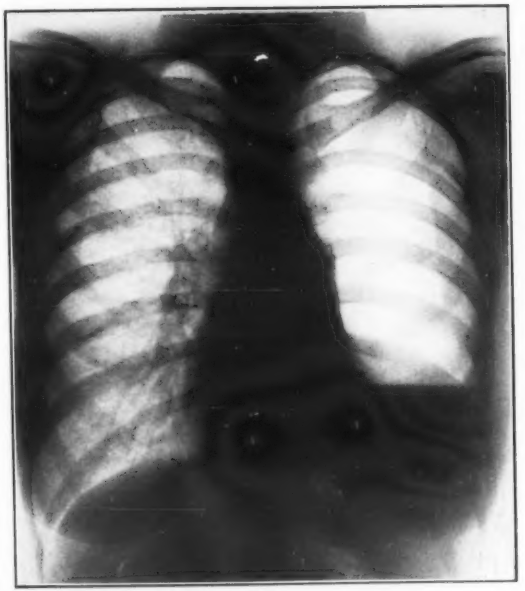


a *b*

FIG. 2.—*a*, CONTRASELECTIVE PNEUMOTHORAX WITH AN APICAL CAVITY STILL UNCOLLAPSED AFTER ALL POSSIBLE ADHESIONS HAD BEEN CAUTERIZED. *b*, AFTER PERFORMANCE OF EXTRAPLEURAL PNEUMOTHORAX. Note the way in which the pleural septum is clearly preventing collapse of the cavity.

PLATE XIV

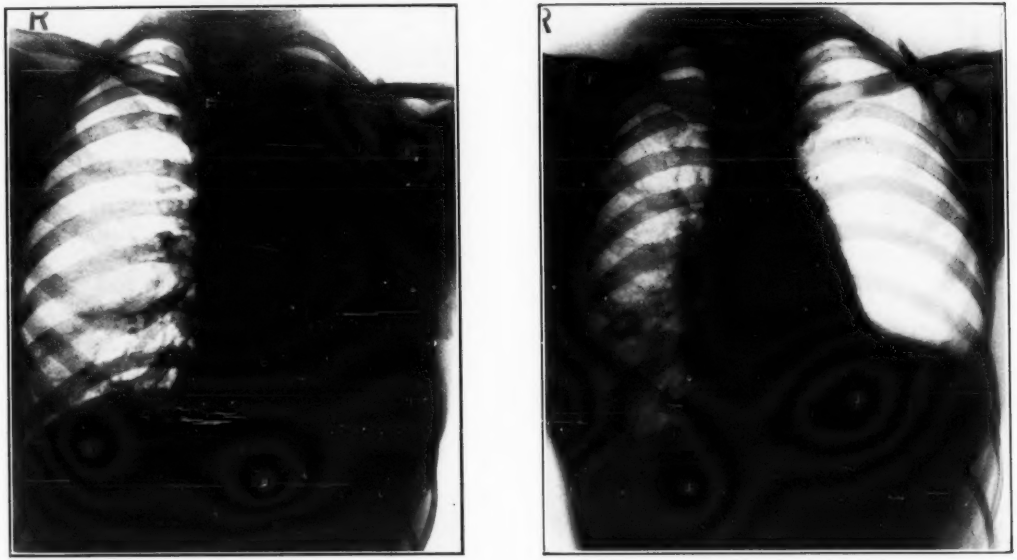
c



d

FIG. 2.—*c*, *d*, THE SAME AFTER DIVISION OF THE SEPTUM AND FUSION OF INTRA- AND EXTRAPLEURAL PNEUMOTHORACES.

PLATE XV



a *b*

FIG. 3.—*a*, PULMONARY TUBERCULOSIS WITH COMPLETE UNILATERAL BLACK-OUT. *b*, TO SHOW EXTENSIVE EXTRAPLEURAL PNEUMOTHORAX CARRIED DOWN AS FAR AS TENTH RIB BEHIND AND FIFTH RIB IN FRONT.

[To face page 175.

from the mediastinum as far as the hilum from above, from in front, and from behind. Not only is it insufficient to leave the lung partly adherent and to continue forcing refills afterwards, but it is also an extremely dangerous procedure. We all know how dangerous it may be to keep up an intrapleural pneumothorax in the presence of limiting adhesions. In extrapleural pneumothorax it is even more dangerous; progressive bleeding into the cavity follows and rupture of the stretched lung may also occur. I am convinced that if it is found impossible or unsafe to free the apex completely it is quite wrong to attempt to maintain the space obtained, however loth one may be to abandon it.

Just as pleural obliteration may prevent induction of an intrapleural pneumothorax, so may obliteration of the extrapleural planes by dense fibrosis prevent achievement of an extra-pleural pneumothorax. Out of the fifty cases in which I have performed the operation I have been unable to complete it in six. I have learnt a great deal from my experiences in these fifty cases, and one of the most important lessons is that the patient who has a firmly adherent lung which is only freed after long and difficult dissection is the patient who is liable to get the severest reactions and complications afterwards. I am now very unwilling to spend any great effort in, as it were, peeling the lung off the chest wall. Apart from everything else there is the ever-present danger of opening directly into the cavity itself—a calamity which is almost uniformly fatal.

Figs. 1, 2 and 3 show the amount of strip that should be obtained in satisfactory cases. Fig. 1 shows that the original lesion in the first case was confined to the apical part of the lung. The very satisfactory and complete relaxation is well shown; note in particular the way the mediastinal surface has been freed right down to the hilum. In Fig. 3 the original lesion was more extensive, involving almost the whole lung, and in this case the strip was carried right down as far as the diaphragm all the way round. The collapse obtained is nearly as good as that from a satisfactory intrapleural pneumothorax.

When the amount of freeing done is too small, particularly if it is not carried down far enough laterally, the cavity can remain held open. This observation is of interest in connection with the old operation of apicolysis and insertion of paraffin wax. It is clear that unless the disease is minimal, complete relaxation and sound healing could never be obtained unless an enormous quantity of wax were used—much too large an amount to be safe. In most cases I believe that the still active disease was merely obscured by the opacity caused by the wax.

It has been stated by those who still adhere to the use of wax for plombage that we have yet to find the ideal substance for introduction. My reply

is that we have the ideal foreign body all around us, the ordinary atmospheric air, which is cheap, easily procurable, simple to prepare, and is unquestionably the most harmless substance we have for filling a cavity. Moreover, it can be used in virtually unlimited amounts, much larger than would be possible with paraffin wax. Finally, it is so labile that again we are able to make constant and exact adjustments of pressure, a safety feature which is impossible when wax or oil is used.

I am convinced myself that the operation of wax plombage is obsolete, and its only place now should be as an item of surgical history. Although there may be an occasional indication for the use of oil, I believe that it also should hold no practical place in the management of extrapleural pneumolysis.

Indications for the Operation.

This is the most difficult part of the subject to discuss, partly from our, as yet, incomplete knowledge of the operation, partly from the indefinable uncertainty that is always present in pulmonary tuberculosis. Briefly speaking, I should say that an extrapleural pneumothorax should be done in every case in which it is considered an intrapleural is indicated but fails, and if the general condition of the patient is not too poor or unstable to stand the somewhat greater burden that the operation involves. It seems only logical, if intrapleural pneumothorax has been tried and has failed, to proceed to an extrapleural induction.

In certain cases, of course, one prefers to wait longer after trying intrapleural pneumothorax before proceeding to the greater procedure, but in these it should only be a question of delaying to choose the best time, not discarding the operation. There are other cases in which, owing to the chronicity, extent, and density of the lesion, and particularly when a large thick-walled cavity is present, the only logical treatment is thoracoplasty. Extrapleural pneumothorax is not suitable for these.

One is often asked: Which would you prefer to have yourself, an extrapleural pneumothorax or a thoracoplasty? Such a question cannot be answered in a word or two. There is a type of disease which demands thoracoplasty as the only correct and hopeful form of treatment. Extrapleural pneumothorax in this group is, as I have said before, not only useless, but very dangerous. There is, however, a large group of cases in which intrapleural pneumothorax has failed and in which *before the advent of the extrapleural operation* there was little or no hope of spontaneous recovery without thoracoplasty *eventually*. In many of these failed cases a thoracoplasty was neither indicated nor justifiable in the early stages of treatment,

but became necessary eventually after months or years of illness. It is in this group that we are now able to employ extrapleural pneumothorax as soon as an ordinary intrapleural fails, and without waiting until advance or chronicity of the lesion ultimately demands thoracoplasty. In other words, we are able to prevent the need for the more severe operation. The question, Which would you prefer? is not a fair question. Of course, any sensible person would prefer the minor and less crippling procedure, if it is possible to do it without risk of severe complications. If the disease is old and fibrous, not only is thoracoplasty the desirable remedy, but it is probably safer than attempting the difficult task of stripping the densely adherent lung off the chest wall to produce an extrapleural space. Extrapleural pneumothorax is no substitute for thoracoplasty.

On the other hand, I believe that the caution shown by many continental surgeons in the selection of cases has been too extreme.

To limit the operation to cases showing only a small " central " lesion with a minimum of surrounding reaction is not only depriving many suitable cases of the great benefits that the method undoubtedly holds out, but in addition means performing the operation on many patients who would otherwise get well with much simpler measures.

Extrapleural pneumothorax has the great advantage that it produces a strictly selective collapse, a feature that is particularly important in dealing with bilateral disease. The outlook has been completely changed for many patients with a bilateral lesion who, before this procedure became practicable, were quite unsuitable for any further form of interference once ordinary pneumothorax had failed.

The presence of a bronchogenic spread in the opposite lung has debarred many otherwise promising cases with a large chronic cavity from the benefits of thoracoplasty. The major operation was often performed earlier than was really desirable and with the contralateral lesion not under complete control. A selective extrapleural pneumothorax now enables one to control the recent spread while proceeding to the thoracoplasty at an earlier date and with greater assurance. Fig. 1 illustrates such a case in which the disease on the right side has been completely controlled, thus enabling us to do either an extrapleural pneumothorax on the left side or, more probably, a thoracoplasty if this is impossible.

Bilateral extrapleural pneumothorax is, of course, a perfectly justifiable procedure, as also is an extrapleural on the side opposite to an intrapleural or even above an existing intrapleural on the same side.

In this last connection, however, I have more to say. A problem not infrequently seen is that of the contra-selective pneumothorax in which a large apical cavity remains held out even after expert division of all possible

adhesions. Fig. 2, A shows such a case. Now this type of disease does not really demand thoracoplasty, since it should heal soundly if allowed to relax. As I have already pointed out, many such cases in the past inevitably came to thoracoplasty in the end. By means of an extrapleural pneumolysis we are able to obtain complete separation from the chest wall (Fig. 2, B). It can be seen, however, that although a perfect strip has been secured the cavity is still held out by the septum of pleura that separates the intra- from the extrapleural pneumothorax. The logical thing to do is to divide this barrier, and I have performed this two-stage operation, which has been hitherto undescribed, on seven occasions now and with considerable success. Fig. 2, C and D show further stages in the closure. This use of extrapleural pneumothorax in conjunction with an existing intrapleural pneumothorax is, I believe, a valuable step in treatment and one that should be much used in the future.

In certain selected cases the pleural septum can be divided at once, and the whole manœuvre completed in one stage, as suggested by Mr. Tudor Edwards.

Extrapleural pneumothorax also holds out hope to many of those severe cases of phthisis in young children in which artificial pneumothorax has failed and thoracoplasty is inadvisable. The youngest patient on whom I have performed the operation was aged fifteen years, but I see no reason why even younger children should not be suitable.

After-Care and Complications.

My present practice is to give a "refill" on the table at the end of operation, another the same evening, and then daily for a few days with gradually lengthening intervals, although I am not sure that such frequent refills are really essential. Much higher pressures are used than with intrapleural pneumothorax; in fact, after two to three weeks, readings of +12, +20 are common. Absorption of air soon becomes slower than occurs from an ordinary intrapleural pneumothorax.

Surgical emphysema has not been a troublesome complication; certainly no more than after ordinary adhesion section. My greatest trouble has been with small oozing or from active bleeding into the extrapleural space, and the greatest care is necessary to try and prevent this.

Infection of the space is inevitable at times, but there is just the same liability to the formation of clear or purulent fluid in ordinary pneumothorax treatment, even to the extent of over 15 per cent. in some series of cases.

One of my patients died eight days after operation from a most interesting

and unusual cause. He had, before operation, a large, thick-walled cavity on the right side and some disease on the left. He was not a suitable subject for a thoracoplasty. Actually with my present experience of the operation and its effects I would not have attempted an extrapleural pneumothorax, for I think he was quite unsuitable for that as well. However, at the time we were building up our knowledge and experience and felt that it was justifiable to try it, as no other procedure was likely to help him and he was definitely beginning to go downhill. There are two main reasons why I think he was unsuitable for extrapleural pneumothorax: one is that a large and dense-walled cavity such as he had demands the permanent compression of a Semb thoracoplasty; the other is that this is the type of case in which the dissection is difficult and associated not only with much bleeding and danger of opening into the cavity, but with a big risk of serious complications afterwards.

The actual strip was relatively easy and the patient but little disturbed. A radiograph taken four days after operation showed the cavity much smaller and completely relaxed. He was, however, complaining of great difficulty in bringing up his sputum, and what little did come up was very foul. He died rather unexpectedly eight days after operation and Dr. Houghton of Colindale Hospital obtained a radiograph of the chest. This showed quite clearly that the cavity was distended with fluid, which at autopsy was found to be thick foul pus, thus constituting an abscess cavity holding several ounces of pus. The inner wall of the cavity reached almost to the stem of the eparterial bronchus itself, and it was clear that when the upper lobe was freed and allowed to drop the bronchus of drainage became kinked and obstructed. Had we recognised what was happening we could have placed the patient on his side with the end of the bed raised and perhaps saved his life.

It is remarkable that this does not happen more often in ordinary pneumothorax treatment. I suppose when disease is severe enough to produce a large cavity adhesions are always present to prevent sudden and immediate dislocation. After adhesion section one must clearly be prepared for it and be prepared to give postural treatment to correct the kink.

Mortality.

In my first fifty cases I have lost five patients, a mortality of 10 per cent. I do not expect, however, to lose as many in my next fifty cases, because, apart from greater experience with the operation, I know that certain types of disease are to be avoided if fatal complications are not to occur. In other words, in properly selected suitable cases the mortality should be

a low one.* It must also be remembered that the cases dealt with include not only failures with the ordinary methods, but also patients with serious disease with no future at all unless some active interference is tried.

Results.

I find that many questions are being asked about the results of extrapleural pneumothorax which it is quite impossible to answer in our present state of knowledge of the operation. I can say straight away that although I have had some bad results and some fair results, I have had a much greater number of results that can be called good or even very good. In fact, in my fifty cases up-to-date I would say that 24 or 48 per cent. could be classed as good and 8 or 16 per cent. as very good (total 64 per cent.). Of course these figures must be qualified by stressing that they are *immediate* results and are judged by the efficacy of the collapse obtained of the diseased lung. If one is able to obtain perfect collapse and apparent obliteration of a large cavity or diseased area that was otherwise unamenable to any treatment short of thoracoplasty, I think one is entitled to consider the immediate result as good. The prognosis then goes back to the general prognosis of any case of apparently controlled phthisis; this is roughly the same for any procedure whether it be simple bed-rest, artificial pneumothorax, thoracoplasty or extrapleural pneumothorax. As we all know, just because a patient has an apparent cure with a satisfactory artificial pneumothorax the problem does not end there; at any time fluid or even an empyema may develop or the same lung or the opposite lung may break down. These dangers are common to all forms of therapy in pulmonary tuberculosis and must not be confused as due to, say, extrapleural pneumothorax alone.

I have had some good results which can only be classed as dramatic. I will describe one of these.

Mrs. T. C., aged twenty-seven, had been under the care of Dr. Burrell and Dr. Livingstone with active disease of the upper half of the left lung. Artificial pneumothorax had been tried and failed; I had also performed a phrenic evulsion. When I was asked to see her again, after she had been in hospital on absolute rest for sixteen weeks, she had a complete unilateral opacity of the left lung (Fig. 3, A). She was running a continuous fever and was a miserable, pale-faced individual; her sputum was $\frac{1}{2}$ to 1 ounce in the twenty-four hours and was T.B. positive. I was asked to perform an extrapleural pneumothorax, as she was clearly quite unfit for a thoracoplasty and was showing absolutely no improvement on routine treatment. I was

* I have since performed a further twenty operations with no mortality.

rather against interfering with her, but the wisdom of the physician's advice was amply shown by the result. As you see from Fig. 3, B, I obtained a very complete strip giving a collapse comparable to that obtained with a good intrapleural pneumothorax. Her temperature, which had been unsettled for sixteen weeks even with absolute bed-rest, fell almost immediately, and even more dramatic was the change in her general condition. From being a miserable, pale-faced toxic person, rather inclined to whine, she became cheerful and alert and lost her toxic look, and eight weeks after operation was able to go to Frimley Sanatorium, having been apyrexial for six weeks and with sputum reduced to an occasional trace which was negative.

I will not burden you with more cases—I am sure the other speakers will have many similar good results to show you—neither do I think this is the time or place to go into the question of bad results in detail.

So far as the ultimate fate of the extrapleural pneumothorax is concerned it is impossible at present to give a reasoned answer. After all, we are still uncertain of the ultimate procedure or result in many cases of successful intrapleural pneumothorax. I have had cases now going on for over a year and there is no sign of obliteration of the space. On the other hand, I have some in which creepage and obliteration are already well advanced. There seems little doubt that *if the strip done is extensive enough*, little difficulty will be found in keeping up the pneumothorax. What concerns me more is whether the lung will expand when it is decided to abandon the pneumothorax. We shall only know the answer to this question after several years. In some I am sure it will be a slow or absent process and thoracoplasty may be ultimately needed. This may be a serious criticism in that an initial thoracoplasty would have saved the patient an extra operation and years of refills. In many cases, however, in which we do an extrapleural pneumothorax thoracoplasty is not only undesirable, but would be an impossibly dangerous operation. For cases which are otherwise suitable for thoracoplasty I believe the extrapleural operation should not be initially attempted, and I also believe that as often as we depart from this practice so often shall we find we get less good results from extrapleural pneumothorax.

EXTRA-PLEURAL PNEUMOTHORAX*

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A PROBATIONARY period of varying length must elapse before any new operation can take a legitimate place as an approved surgical procedure. The practice of extra-pleural pneumothorax was very limited in this country until the past year or so, and a reasonable space of time must be allowed to pass before its proper place among operations available in the treatment of pulmonary tuberculosis can be fairly assigned.

This paper must therefore be regarded as an introductory effort to illustrate some of the advantages and complications that have been observed in a personal series of seventy-one cases over a limited period.

In cases in which artificial pneumothorax fails the value of being able to allow retraction of diseased and excavated areas of lung by other means is obvious. It is possible to strip the parietal pleura from the deep surface of the chest wall and so allow collapse of the underlying lung. The result of this is to leave a large raw space which tends to obliterate, and the problem has been how to preserve this space for a sufficiently long period to allow healing of the relaxed lung to take place. Throughout the history of collapse therapy this procedure has made its appearance in different guises, but for various reasons has had to be abandoned. Refilling the space with air, as practised in A.P. treatment, is apparently a simple answer, but technical difficulties often led to failure. However, it is now felt that a more extensive pneumolysis and more detailed attention to the control of the refills are producing a solution to the problem.

The operation is based on the relative ease with which the parietal pleura can be stripped off the deep surface of the ribs in the plane of the endothoracic fascia—an observation frequently made at post-mortem examination. In every case the apex must be stripped free as possible, though the cases when this can be done vary considerably on account of the extent of the inflammatory adhesion of pleura to the chest wall. The pneumolysis should be carried on widely over all aspects to ensure a free concentric collapse of the diseased area, and frequent refills with air coupled with aspiration of blood or serum form the basis of after-treatment.

* A paper read at the Oxford meeting of the Tuberculosis Association in April.

One of the most important considerations is to estimate the severity and danger of the operation. To look on it as something only a little more serious than induction of an ordinary A.P. is decidedly erroneous, but its accompanying constitutional disturbance is a good deal less than that in a thoracoplasty. It has also a considerable advantage in that it can be used in the large group of A.P. cases where the diseased apex of the lung is adherent and where collapse is contra-selective.

Indications for operation are best considered under two main headings:

1. Cases in which the pleural space has been obliterated and in which there is an upper zone area of disease whose collapse is desirable.

2. Cases in which an A.P. is present, but where the collapse is rendered ineffective by adhesions that cannot be divided by thoracoscopy.

Cases in Group 1 include those in which A.P. has been tried unsuccessfully, but do not necessarily include those ordinarily considered as suitable for thoracoplasty. The temporary nature of the collapse obtained by extra-pleural pneumothorax cannot be regarded as the equal of a permanent selective collapse that a thoracoplasty may give, but it so happens that the very contra-indications to thoracoplasty frequently constitute the main indications for the operation under discussion.

These may be summarised:—

1. Character of the disease:
   (*a*) Too recent or " soft " for thoracoplasty.
   (*b*) Rapid excavation with obvious need for retraction.
2. Situation of the disease:
   Presence of recent activity in the opposite lung.
3. Age of the patient:
   In growing children extensive rib resection may be postponed or avoided.
4. Patients who refuse to entertain the idea of a thoracoplasty.

When an A.P. is present it is first wise to make sure of the extent of the adherent area by thoracoscopy and ensure that the adhesions are not divisible intrapleurally. If the extra-pleural operation is resorted to several courses are open:

1. Maintaining of both intra- and extra-pleural spaces with air refills.

2. Division of the septum or partition between these pleural spaces with thoracoscope and cautery at a later date. This has the effect of producing one large intra-pleural pneumothorax, which is treated as such.

3. Division of the septum at the time of operation—a procedure practicable only if the extra-pleural area is dry and free from blood.

4. A modification of the last procedure consists of a deliberate trans-

pleural opening into the chest and incision of the parietal pleura round the adherent area. The lung is then stripped clear from the chest wall or mediastinum and a satisfactory collapse is obtained with the minimum of damage to the pleural membrane.

This last operation is very similar to an open division of adhesions and is confined to limited areas of fusion. I practised this, as well as other forms of pneumolysis, in selected cases for some time before attempting an actual extra-pleural pneumothorax as such, and have excluded these cases from the present series.

The technique of the operation presents many minor variations which do not, however, affect the main principles. Anæsthesia, as for all tuberculous patients, is a problem. Local anæsthesia alone can be very satisfactory in tolerant patients, but I have had the misfortune to have seen several patients suffer from violent and intractable fits of coughing as the anæsthesia wore off. Cyclopropane gives quiet and smooth respirations, but has the disadvantage of precluding the use of diathermy on account of its inflammability. Gas and oxygen is good, but gives occasional awkward moments while the pleura is being stripped off the mediastinum, and is hardly adequate for patients whose ventilation surface is greatly reduced. At present I prefer reasonably heavy premedication followed by gas and oxygen, with a regional paravertebral block.

The site of the incision is between the vertebral border of the scapula and the spinal column at the level of the third, fourth, or fifth rib. An oblique incision parallel to rib avoids cutting across some muscle which would have to be divided with a vertical approach. Formerly I used to resect 3 to 4 inches of a rib and reach the plane of the endothoracic fascia through the rib bed, but now I divide the posterior ends of one or two ribs deep to the erector spinæ mass and use an intercostal incision. Judicious use of a rib spreader then gives good exposure, and at the completion of the operation pericostal suture allows a more satisfactory closure than if rib had been removed.

The freeing of the parietal pleura from the chest wall is a question of slow dissection with fingers, swabs, or blunt instruments; scissors, knives, etc., should not be employed. Extreme care must be exercised to avoid tearing the pleura, which in some cases is as thin as tissue paper. Firm adhesion is practically always to be encountered over the apex, in particular at its posterior and mesial angle. In these areas dissection must be carried out even more carefully and under direct vision. A malleable lamp or endoscope which can be sterilised is of great advantage. Dissection of the mediastinal pleura is invariably anxious; on the right side the great veins are laid bare and any injury to them or to small vessels in the neigh-

PLATE XVI

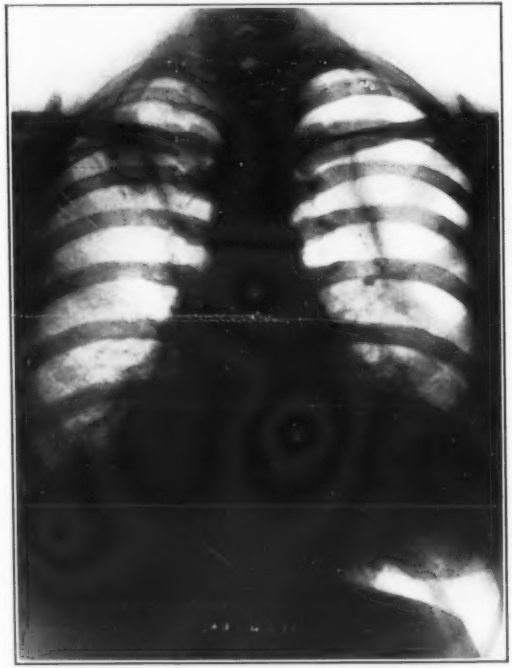

FIG. 1.—CAVITATION IN RIGHT CLAVICULAR REGION.
A.P. in progress, left side.

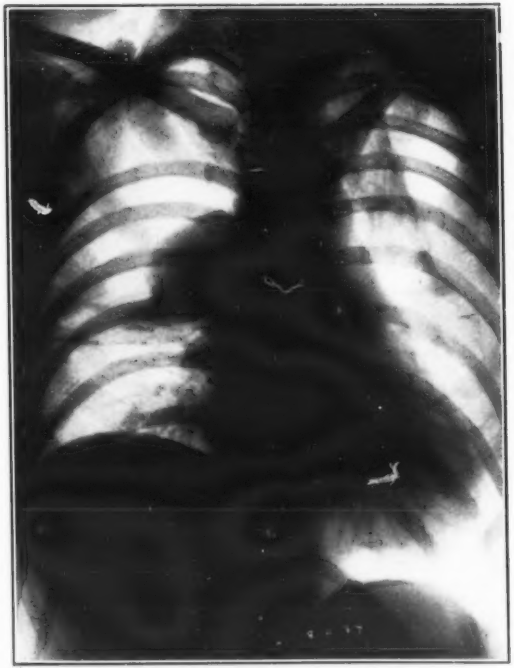

FIG. 2.—SELECTIVE COLLAPSE OBTAINED BY RIGHT EXTRAPLEURAL PNEUMOTHORAX.

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PLATE XVII

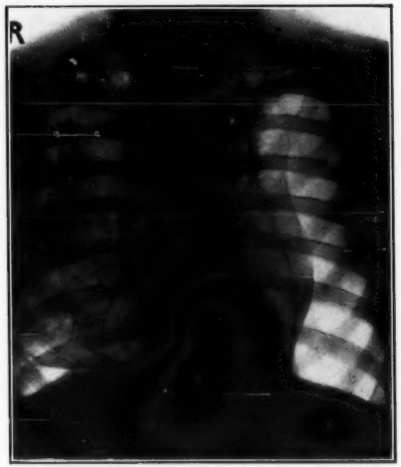

FIG. 3.—BILATERAL A.P.
Contraselective on both sides.

FIG. 4.—RIGHT EXTRAPLEURAL PNEUMOTHORAX.
Septum shows as a fine curved line, and was later divided through the thoracoscope.

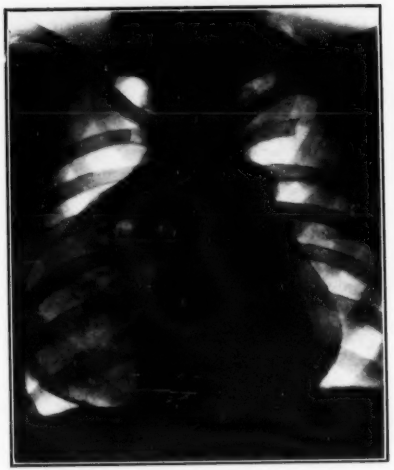

FIG. 5.—THREE MONTHS LATER LEFT APEX FREED BY EXTRAPLEURAL PNEUMOLYSIS, SEPTUM BEING CUT THROUGH AT THE TIME OF OPERATION.
Patient is now fit, and is controlled as a bilateral selective pneumothorax.

PLATE XVIII

FIG. 6.—LEFT A.P. IN PROGRESS.
Large cavity held open at the apex.

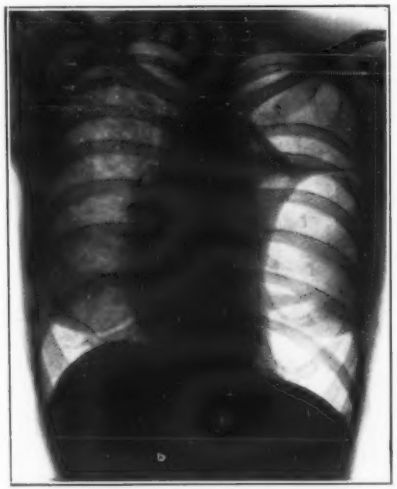

FIG. 7.—EXTRAPLEURAL PNEUMOTHORAX, SHOWING FORMATION OF "SEPTUM" BETWEEN INTRA- AND EXTRA-PLEURAL SPACES.
Cavity well depressed but still obvious.

FIG. 8.—FINAL RESULT AFTER DIVISION OF SEPTUM BY THORACOSCOPE.
Complete collapse of cavity. Trace of fluid in chest. Clinically and anatomically satisfactory.

PLATE XIX

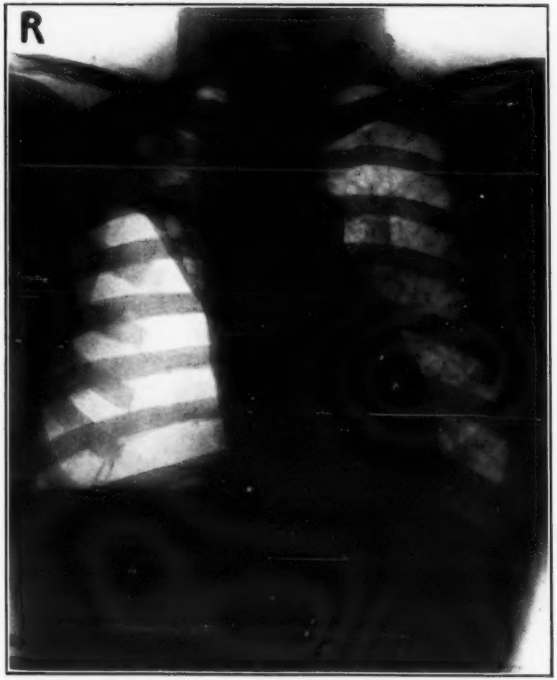

FIG. 9.—CONTRASELECTIVE RIGHT A.P. WITH ADHERENT APICAL CAVITATION.

FIG. 10.—AFTER EXTRAPLEURAL PNEUMOTHORAX. "BLACK-OUT" DUE TO HÆMORRHAGE INTO DEAD SPACE.

Patient was left strictly alone and the hæmatoma liquefied slowly, and was aspirated with good result.

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bourhood may occasion bleeding which is difficult to stop. Moreover, a varied amount of shock is encountered, possibly depending on the fixity of the mediastinum; some patients apparently suffer only slight disturbance, while others develop a rapid pulse with signs of distress and coughing and straining.

When the stripping is complete, careful search must be made for all bleeding points, particularly from small perforating vessels in and about the heads and necks of ribs and on the mediastinal apex. Where swab pressure does not stop bleeding, diathermy coagulation proves effective. It should be remembered that though stripping can be carried down on the deep rib surface almost to the diaphragm, the hilum is the limit of dissection on the mediastinum. The degree of firmness with which the pleura is fused to the ribs varies enormously. Some cases strip almost of their own accord, while others are so tough and adherent that formation even of a small space produces a marked degree of shock. In extreme instances of the latter it may be well advised to abandon the operation and to consider substitution of a thoracoplasty.

The operation is completed by a careful suture of the wound in layers with the aim of making the extra-pleural space air-tight. Finally, an A.P. needle is inserted, and the pressure adjusted in the first instance to about +4 to +10 cm. water. If the extra-pleural space has been connected with an intra-pleural one at the time of operation the cavity must clearly be treated as an ordinary A.P.

Some subcutaneous emphysema is a frequent immediate sequel to the operation, and may be minimised by judicious use of morphia to control post-operative cough. The subsequent course of treatment can briefly be described as frequent refills and removal of all blood-stained effusion with the regular control by X-rays. In an average case a refill in twelve hours is followed by aspiration and refill the next day; then almost daily refills for a week or ten days, keeping the pressure high (up to +10 to +15 cm.). The drier that the space can be kept the more satisfactory the result appears to be in most cases. When the cavity remains free from fluid the refills can be spaced so as just to prevent any "creeping out" or re-expansion.

In a case which has stripped fairly easily there is usually an increase in the size of the space, due to weight of effusion and air pressure, during the first few days. After that a continual watch has to be kept against re-expansion, which may occur quickly and reduce a large extra-pleural space to a small ineffective pocket at the apex.

So far we have not been able to determine satisfactorily the fate of the space, assuming that the pneumothorax is kept up for a long period. Can

it be adequately maintained and for long enough to allow pulmonary cavities to close and remain healed? If, and when, the pneumothorax is abandoned, will the lung re-expand completely and become adherent to the chest wall? These are questions that time alone will answer.

In the case of the extra-pleural which is connected to an existing intrapleural pneumothorax the reply is rather easier. Large cavities can be seen to diminish in size, and to close up in about the time allowed for a similar cavity in an ordinary complete A.P. There is no reason why this type of case should behave in any way differently from the complete selective A.P. into which it has been converted.

It is clear that the operation is open to those complications which may occur during the course of any collapse operation, and aspiration and activation of disease in the opposite lung have been seen. Spread of disease in the opposite mid-zone has been noted on five occasions in these series, and there was one death from broncho-pneumonia in the opposite lung within a week of operation.

Apart from this there are those complications which can be attributed to the operation itself. Subcutaneous emphysema has already been mentioned, and also the tendency of the lung to " blow out " or re-expand as a result of coughing. In one case after extensive stripping the space was completely obliterated within a few hours, and efforts to re-establish it failed. An operative attempt to form the space again was only partially successful, but we feel that this attempt should be made in similar cases. The tendency for re-expansion to occur early is marked in some instances after extensive stripping, but the apical area is slow to obliterate. In view of some satisfactory functional results I have no hesitation in performing a limited operation in order to tide the patient over a bad phase of disease.

Next comes the question of infection. When one thinks of the area of tissue torn across and how lymphatics may be damaged over lung that is admittedly diseased, it is surprising how little results. Refills must be performed with the most scrupulous asepsis, and the withdrawal of fluid as it collects deprives organisms of a culture medium in a raw traumatised area. Occasional late infection some weeks or months after with a tuberculous effusion does occur, but the most grave complication is one that can be more directly attributed to the actual operation, and that is injury to the walls of an underlying cavity. The result may well be rupture of the tuberculous cavity with disastrous result from what is the equivalent of an extensive mixed infection empyema. This occurred in one instance a week after the operation in a case in which it was known that the cavity

was unduly adherent to the chest wall. The corollary to this is that discretion in abandoning the operation is superior to surgical courage in proceeding over dangerous ground.

Bleeding and effusion are to some extent inevitable. With the small opening into the chest it is possible to overlook a bleeding point in some relatively inaccessible part, and the additional stripping that may occur after completion of the actual operation probably accounts for some cases of later bleeding. The importance of efficient aspiration is well illustrated by the formation of fibrous masses and loculation of fluid if this is delayed. Viewed through a thoracoscope, the interior of the chest presents a frothy mixture of fibrin and bloody serum in this event.

Another point to bear in mind connected with aspiration is the fact that the intercostal tissues have lost their pleural support, and any slight hæmorrhage produced by needle puncture will result in a steady trickle into the cavity instead of the subpleural hæmatoma which would be the usual sequel. In cases in which the intra- and extra-pleural components have been thrown into one it is especially important to keep the space dry and avoid irritation of the pleura by blood.

This rather formidable list of complications should not, however, act as a deterrent to the practice of extra-pleural pneumothorax. Some of the misadventures have clearly resulted from lack of experience and faulty technique. The uncertain factor of lung re-expansion is the main problem that besets the control of the operation, and a full share of responsibility has to be borne by those carrying out the after-treatment. It is, however, some consolation that even if the space cannot be maintained as fully as desired, it may suffice to produce sufficient temporary improvement and allow the performance of a thoracoplasty which previously could not have been contemplated. In this series of cases none have yet come to this major operation, though there are several in which it is considered probable.

A more decisive result can be obtained where the extra-pleural space has been thrown into an A.P. Large lung cavities which are freed can be seen to contract and finally close, while before this operation was devised they were impracticable for surgery. Out of thirty-three cases of this order, twenty-one have produced for the first time negative sputum with radiological closure of the cavity, and it is hoped that the same effect will be achieved in several of the remainder as time proceeds.

When stabilised, it seems reasonable to suppose that these cases will be subjected to no more dangers than are encountered in the course of an A.P., though strictly the operation has ceased to be a true extra-pleural pneumothorax.

	FIGURES.	
In absence of A.P.		
Extra-pleural pneumothorax only ..	33	1 death from rupture of cavity. 7 failures: either infection or early re-expansion.
In presence of A.P.		
Extra-pleural pneumothorax only. Septum left intact	5	
Extra-pleural space communicated with A.P. by later division of septum ..	9	2 cases of tuberculous infection of pleura.
Extra-pleural pneumolysis with division of septum at time of operation	24	1 death from pneumonia in opposite lung. 4 cases of pleural infection.

PLATE XX

FIG. 1.—PARTIAL COLLAPSE OF LEFT LUNG, BUT TWO LARGE CAVITIES STILL PATENT. LARGE CAVITY RIGHT APEX.

FIG. 2.—SAME CASE EIGHTEEN MONTHS LATER. IMPROVED COLLAPSE LEFT LUNG AFTER CAUTERIZATION OF ADHESIONS.

Pneumothorax on right has failed to collapse cavity on account of adhesion.

FIG. 3.—FOURTEEN MONTHS LATER CAVITIES HAVE CLOSED ON BOTH SIDES.

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CONSULTATION

By A. J. MORLAND,
M.D., B.S., M.R.C.P., M.R.C.S.

The patient was a bank clerk aged twenty-seven when, in the autumn of 1933, a diagnosis of pulmonary tuberculosis was made. His symptoms dated from an appendicectomy eighteen months previously, since which he had had a cough and sputum, followed of recent weeks by night sweats and an evening temperature up to 101°. The weight was 10 stone 3 pounds (H.K.W.=12 stone). He was sent to Mundesley Sanatorium, where he was found to have 1 to 2 ounces of muco-purulent strongly T.B.+ sputum. Moist râles were heard over the upper two-thirds of the left lung and a few fine post-tussive crepitations could also be heard at the right apex. X-ray showed two large cavities on the left and a definite subclavicular infiltration on the right.

After a fortnight's rest in bed an A.P. was started on the left side; although adhesions prevented the effective collapse of the lung, the temperature gradually came down to normal, the weight went up about 5 pounds, and the sputum was reduced to less than 1 drachm. Two courses of sanocrysin were given in the spring and summer of 1934 and a left phrenic evulsion was performed in September, 1934. About the same time the patient was put on silence for two months, as examination of the larynx showed doubtful infiltration of both vocal cords and a deposit in the interarytenoid space. Progress was satisfactory until November, 1934, when cough and sputum increased, fever returned, and X-ray examination showed a large thin-walled cavity on the right side (Fig. 1). As this had increased in size after a month's rest in bed a bilateral pneumothorax was started, and once more, although adhesions prevented the cavity from collapsing, the temperature became normal and the sputum much reduced.

In October, 1935, the patient was taken to see Dr. F. G. Chandler, who subsequently cut two large adhesions on the left side; an apical band was left alone, as it could not be divided with safety. As a result of this intervention a much better collapse was obtained; the lower of the two cavities closed and the upper was reduced to a narrow slit. An interesting discussion took place at this time about the advisability of cutting the adhesion holding out the cavity on the right side. The problem was briefly as follows (see Fig. 2): The left lung was permanently useless; the right upper lobe

contained a large thin-walled cavity, but the lower and middle lobes were unaffected; the patient was afebrile and had only 1 drachm of sputum (T.B.+) and was not short of breath in the least. It was decided that although the adhesion on the right was probably cutable, it was wiser at any rate to postpone the operation for a year or more on account of the risk of a pleural effusion, which would almost certainly reduce his respiratory efficiency to an incapacitating level, if it did not immediately cost him his life.

Refills were continued at fortnightly intervals on the right side, the pressures being kept very negative, average readings being – 18 – 10, 600 c.c. –8 – 4. The left side only required monthly refills of 200 to 300 c.c., the final pressure being slightly positive. In the spring of 1937 the sputum finally disappeared and has not returned; an X-ray taken in July, 1937 (Fig. 3), showed apparent closure of the cavity on the right, and this condition has been maintained. The patient has been living at home doing part-time work; he drives a car, but is not encouraged to walk more than a mile. He is short of breath on stairs, but not on the level; the weight is stationary at about 10 stone 9 pounds.

The problem of the future is an interesting one. The *right lung* has now been collapsed for three and a half years, but as the cavity has only been closed a year I think that the low pressure A.P. should be continued for about another two years. The *left lung* is probably permanently useless, and I think the A.P. should be continued indefinitely. The arguments against giving up this A.P. are:

(1) The lung is useless anyway.

(2) If refills are stopped the mediastinum will be displaced to the left, with consequent enlargement of the right hemithorax. Should this be permitted, there would in my opinion be considerable danger of pulling open the cavity in the right upper lobe.

MEETINGS OF SOCIETIES

THE TUBERCULOSIS ASSOCIATION

A MEETING of the Association was held in London on Friday, May 20, 1938, with Dr. S. R. Gloyne, the President, in the Chair. At the first session the subject for discussion was "Trauma and Tuberculosis." This was opened by Dr. J. Browning Alexander, who said he would confine his remarks to trauma in relation to pulmonary tuberculosis, and defining "trauma" for the purposes of the discussion as "injury caused by external violence." Since tuberculosis could only be caused in the first place by the tubercle bacillus and by no other agent, what they had to consider was how trauma could reactivate an old quiescent lesion or aggravate an already existing infection. As to the first point, there was ample clinical evidence of its possibility, but experimental confirmation was scanty and difficult to obtain, largely because of the susceptibility and rapid death of animals infected with the tubercle bacillus. In a patient already suffering from pulmonary tuberculosis, and especially in one with long-standing chronic disease, a blow to the chest wall might result in a severe hæmorrhage and dissemination of the tubercle bacilli to hitherto unaffected parts of the lungs. Serious aggravation should show itself in three or four days after the accident by fever and the X-ray appearances of freshly developed broncho-pneumonia. A "spread" demonstrated for the first time three or four months later was not likely to be due to the hæmorrhage. It was, therefore, important to give full consideration to the time elapsing between injury and spread of disease before forming an opinion as to the causal relationship. Trauma, when followed immediately by such sequelæ as spontaneous pneumothorax or pneumo-pericardium, must be admitted as causing aggravation of a pre-existing lesion. The usual causes of spontaneous pneumothorax were the ulceration of a subpleural tubercle, the rupture of an emphysematous bulla, or the tearing of an adhesion immediately above the diseased portion of a lung. Apart from stabbing or fracture of a rib, a healthy lung did not rupture. Another form of tuberculosis which might reasonably be attributed to trauma was miliary tuberculosis, as in a case cited by Parkes Weber, where a blow on a tuberculous testicle led to the dissemination of tuberculosis in the lungs, or in another case where miliary spread took place after forcible manipulation of a tuberculous joint. More difficult cases were those in which pulmonary tuberculosis arose after trauma to a part of the body outside the chest. For example, a man with a fractured femur might become debilitated from prolonged residence in hospital and later succumb to tuber-

culosis. In such a case the causal relationship would have to be decided by consideration of the sequence of events in the interval. The complete absence of signs or symptoms of tuberculosis for, say, three months after the accident would negative any causal relationship between the two events. In conclusion, the speaker emphasised the fact that since trauma was undoubtedly capable of activating some focus of pulmonary tuberculosis which might have been quiescent for years, the question as to whether the trauma was responsible must be determined by a careful evaluation of all the facts in each individual case, paying particular attention to the time factor.

Dr. J. G. Johnstone, O.B.E., M.C., discussing the question as it related to tuberculosis of bones and joints, said that a study of the vascular supply of those parts that were liable to become primarily infected was important. These areas were the epiphyses, metaphyses, and the synovial membranes. The minute vascular arrangement at the epiphysis and metaphysis of bones was different from the diaphysis. Although the bloodvessels were abundant, the minute arterial capillaries terminated in a widened bay with a poor venous return, and there was a distinct diminution of the phagocytic cellular elements of the blood, in contrast to the medulla, where the blood supply was not only abundant and rapid, but was also rich in cellular elements. A combination of sluggishness in the blood stream and lack of phagocytic elements in a given site rendered it more vulnerable to hæmatogenous infection—a vulnerability which was obviously increased by trauma. In acute infections the relationship was more easily established than was the case with tuberculosis. If any relationship existed between trauma and tuberculosis of bones and joints it was usually in association with a minor injury; he could not personally recall a single case of gross joint injury that developed tuberculous arthritis in the injured part. From the many hundred cases that had passed through his hands he placed trauma as a causal factor in some 15 to 20 per cent. In four other groups it was easier to incriminate trauma as the predisposing cause: (1) Traumatic inoculation of tubercle bacilli; (2) traumatic exacerbation of a latent but active lesion; (3) traumatic aggravation of a known active lesion; (4) traumatic reactivation of an old healed lesion. In all these groups there was a reduction or even absence of time-lag between the injury and the appearance of clinical symptoms, and in all the X-ray evidence of mischief was more conclusive. Cases in Group I. occurred mainly among people who worked amidst tuberculous infected material—surgeons, veterinary surgeons, prosectors and butchers. Group II. contained many cases of tuberculosis with such a slowly progressive course that the focus might be well advanced before any inconvenience brought the patient to seek advice. Trauma in such cases undoubtedly quickened the activity of the tuberculous process. In Group III. there was also ample and speedy evidence of the effect of trauma upon an existing active tuberculous focus, leading to an extension of the destructive process and only too often to dissemination of the disease. Group IV. also gave abundant evidence of the effect of injury upon a site in which tubercle bacilli had been implanted and had remained inactive for a varying period of time. All workers in tuberculous orthopædic conditions recognised the danger of relapse in certain types of articular end results. Reactivation

was most prevalent in joints in which there had resulted an unsound ankylosis or any limited range of movement arising from changes in the joint surfaces or from adhesions. Such joints were very liable to overstrain, resulting in a lowered resistance to the lurking tubercle bacillus. Cases of unsound ankylosis were well recognised as supplying the vast majority of recurrences with trauma as the main cause of return. Trauma must therefore be regarded as a definite predisposing cause of tuberculous disease of bones and joints, the chief difficulty encountered being to decide in which cases it was the main factor amongst others operating at the same time.

The next speaker, Mr. C. A. Collingwood, Barrister at Law, tackled the subject from a legal point of view. He said that tuberculosis being a specific bacterial disease, its local traumatic inception implied either (1) that the bacillus had been directly introduced into the system; (2) that the bacillus was already present, lying dormant in the tissues, and that the injured part was for the time being a *locus minoris resistentiæ*; (3) that a pre-existent though quiescent tuberculous lesion had been aggravated. After alluding briefly to cases arising from policies against death or accident with exceptions relating to general or specific diseases, Mr. Collingwood went on to say that by far the greater number of claims in respect of tuberculosis consequent upon trauma were those brought under the Workmen's Compensation Act. In this Act the word accident was used in the ordinary sense of any untoward and unexpected event which occasioned hurt or loss. If the workman could show that his disease was a consequential result of accidental circumstances arising out of and in the course of his employment, he would be entitled to compensation. Injury by disease alone, unaccompanied by accidental circumstances, was not one for which compensation could be claimed, except under the provisions of the Act relating to scheduled industrial diseases, or to silicosis or asbestosis; nor did the fact that one man was more susceptible to infection than another constitute an accident. But, given an accidental occurrence, the fact that at the time of the occurrence the man was suffering from a condition which made him more susceptible to injury would not prevent the occurrence from being accidental. The test applied was whether in substance the accident came from the disease alone, so that whatever the man had been doing it would probably have come all the same, or whether the employment contributed to it. In some cases distinction had to be drawn between aggravation and acceleration of the disease. When death resulted from the injury, it was immaterial that the deceased was suffering from such a condition of tuberculosis as would certainly have proved fatal in a short time apart altogether from the accident. This was because compensation in the case of death was a lump sum payable to the dependents of the deceased, thus differing from compensation for incapacity, payable weekly during incapacity. Where the effect of accident on a man already suffering from tuberculosis (or any other disease) was to accelerate the disease so that he was put into a condition of incapacity sooner than he would otherwise have been, then the incapacity due to the accident would not last beyond the date at which he would in any event have been incapacitated. The question whether in a given case death or incapacity resulted from the injury resolved itself into a purely medical enquiry into the " chain of

causation," and whether this chain was broken by a *novus actus interveniens* —*i.e.*, a new act which gives fresh origin to the after-consequences. In this latter case the man could not succeed in his claim. The large number of cases which occurred in this branch of the law and the gravity of the issues involved, rendered the subject one of great medical and surgical importance.

In a short discussion which followed, Dr. Alexander Brownlie pointed out that, although it was true, as the first speaker had said, that the tubercle bacillus was the definite cause of tuberculosis, they had to remember that a very large proportion of the population had already at some time been infected with the disease without having shown any recognisable sign of the disease, perhaps for as much as twenty years. If in such a case after an injury or accident tuberculosis did develop, and the case was fought out, it would be difficult to convince the court or the jury that there was no connection between the accident and the illness in a man who had previously been in apparently perfect health. In the case of children suffering from tuberculosis there was generally a history of antecedent injury. This was not the case in adults, however. For the past twenty-five years he had had a large number of professional footballers under his care suffering from injuries ranging from mild bruising up to severe fractures and concussion. He had never yet seen tuberculosis develop in one of the cases, possibly partly because these men were in first-class physical condition.

Dr. Reade cited the case of a child who died from miliary tuberculosis. There was no previous history of contact or known infection, and the only trauma that could be suggested was the extraction of two teeth under an anæsthetic.

Dr. Tattersall suggested that an injury to the chest of a crushing rather than a penetrating type was much more likely to lead to tuberculosis. He agreed as to the importance of the duration of the interval between the accident and the appearance of symptoms. He instanced a case in which a patient a year after a small accident on a football field developed a severe type of tuberculosis. In this case he had never felt fit since the accident. It was important, therefore, to investigate " bridge symptoms." He asked Mr. Collingwood if there was in English law any fixed interval beyond which no claim could be made. German law, he believed, allowed six months for a claim for aggravation of existing disease, and two years where the disease could be more directly attributable to the trauma.

Mr. Roberts, F.R.C.S., said that since legal decisions must in these cases rest on medical evidence, they should not lightly give an opinion without a solid basis. A case of his was that of a window cleaner who fell in a standing position, fracturing both ossa calcis. He was in perfect health when he fell. Twenty-four hours later he had cough and sputum. The sputum was examined, as was invariably done in his ward; it was found to be full of tubercle bacilli, and an X-ray of his chest showed advanced tuberculosis of his right lung. Had he not been in the speaker's ward, where these sputum examinations were the rule, the case could easily at a later date have been put down to a traumatic reactivation. Unless great care was taken by a medical man in giving evidence, it might be found later that his opinion was not warranted by the facts.

Dr. F. R. Walters said he had looked through the records of 400 pre-war cases, and had been struck with the very small number (only five) in which trauma was responsible. Apart from these five, there were sixty-seven cases of pleurisy. Unlike cases of tuberculosis of bones and joints, pulmonary tuberculosis evidently seldom resulted from trauma. Another speaker asked if it was not rare for compensation to be claimed for tuberculosis following trauma.

Dr. Alexander, replying, said he had tried to point out that ordinary normal lung did not rupture, but a sudden strain might produce a tear. An ordinary blow, unless over a cavity, would be unlikely to cause a hæmorrhage.

Mr. Collingwood replied that the Act gave a time limit of six months, but a large number of " reasonable causes " were admitted for prolonging this period almost indefinitely. Far from it being rare for compensation to be claimed for tuberculosis following trauma, he had had four within the past week alone.

At the evening session Dr. J. T. Hunter opened a discussion on " Anæsthetics in Thoracic Surgery." He said that there was no other branch of surgery in which the anæsthetist had to face such great difficulties, whether the operations were intra- or extra-pleural. This was due partly to the technical problems involved, and partly to the fact that in the types of disease for which thoracic operation was undertaken the patient was usually toxic or debilitated from a long illness, and had, moreover, a lowered vital capacity which increased the risks of inhalation therapy. No one method of anæsthesia could be suitable for all operations in thoracic surgery; the anæsthetist had to decide whether to use local infiltration, general anæsthesia or special analgesia, alone or combined with an intravenous or an inhalation anæsthetic. In such intrapleural operations as pneumonectomy or lobectomy there was the further problem as to the wisdom of using intratracheal or intrabronchial intubation with suction. Preliminary medication should always be light, and no drug used which would tend to diminish the cough reflex to any extent. The most useful combination was probably omnopon $\frac{1}{3}$ grain with scopolamine $\frac{1}{100}$ grain, given three-quarters of an hour before operation. Postural drainage should also be carried out as a preliminary measure where there was any sputum, and in intrapleural operations an A.P. should be induced some three or four days previously. For the operation itself local anæsthesia was used extensively on the Continent, but very little in this country, except for such operations as induction of A.P., rib resection for empyema, or operations on the phrenic nerve, for all of which an infiltration of 1 per cent. novocaine might be sufficient, with a small injection of sodium pentothal for phrenic evulsion. High spinal analgesia had proved excellent in lower lobectomy and thoracoplasty, the chief advantages being as follows: (1) Bleeding was reduced to a minimum; (2) the cough reflex was unimpaired; (3) respiration was unimpaired, with no sign of cyanosis. The disadvantages included the occasional occurrence of post-operative headache and a fall in blood pressure.

General anæsthesia was, however, more commonly used in this country for thoracoplasty, apicolysis, for the establishment of extra-pleural pneumo-

thorax, and for lobectomy and pneumonectomy. Of these agents, ether was quite unsuitable in thoracic surgery. The toxic effect on the liver of chloroform anæsthesia was a factor which could not be overlooked, but given in minute doses as an adjunct to gas and oxygen it might be useful in difficult cases. Divinyl ether, which was not as toxic as chloroform, could also be used in this way. Nitrous oxide oxygen had many advantages, in that it was non-toxic, non-irritating, and was speedily eliminated; but since very little oxygen could be given in the mixture it was difficult to keep up a steady anæsthesia without the help of chloroform or divinyl ether. Cyclopropane, one of the newest inhalation anæsthetics, was very nearly ideal in suitable cases, especially as it could be given with a very high percentage of oxygen. Other advantages were that it reduced respiratory movement to a minimum, that it was non-toxic and non-irritant, and was nearly as rapidly excreted as nitrous oxide oxygen. The induction was rapid and pleasant, and the cough reflex could easily be maintained. It had, however, the disadvantages of increased bleeding and the lengthening of operation time. The speaker himself still used nitrous oxide oxygen, combined with careful premedication, for thoracoplastic operations, this routine anæsthesia having given excellent results over a number of years. For apicolysis and extrapleural pneumothorax, where quiet respiration and minimum of movement were essential, cyclopropane had proved vastly superior to nitrous oxide oxygen. For cases of thoracotomy, where operations for abscess, carcinoma, or mediastinal tumours were to be carried out, spinal anæsthesia might be suitable if there was little or no sputum. With copious sputum, tracheal or bronchial intubation must be resorted to. At the Brompton Hospital bronchoscopy was always carried out under local anæsthesia, with the preliminary use of omnopon and scopolamine. It was quite certain that improvements in anæsthetic technique had done much to help the thoracic surgeon in the formidable operative procedures undertaken in the present day.

Mr. J. B. Hunter, F.R.C.S., speaking from the point of view of the surgeon, said that the requirements for an anæsthetic were that it should be safe, should not upset the patient mentally, should reduce movement to a minimum, and should be free from complications. Local anæsthesia was doubtless the safest, and was usually combined with morphia, omnopon, and scopolamine, or nembutal. Ether was quite unsuitable for all lung cases, but had a place in operations on the heart, especially cardiolysis, where basal narcotics were best avoided. Gas and oxygen anæsthesia, although it was safe, had the disadvantage of causing considerable respiratory movement. This, however, could be largely overcome by adequate CO_2 absorption arrangements, and the proper administration of basal anæsthetics. In this connection he thought that there was a wide field for improvement in the CO_2 absorption apparatus, which anæsthetists might well explore more fully. He had had little personal experience of cyclopropane, which had two great disadvantages: (1) Diathermy could not safely be used except in the presence of an absolutely closed circuit; and (2) hæmorrhage from the wound appeared to be very much greater than with other forms of anæsthetic. Spinal anæsthesia necessitated the patient being either conscious

or under the influence of previously administered basal anæsthetics. No advantage would thus seem to be gained by its use, since relaxation was not a necessity in chest surgery, and spinal anæsthesia was not free from post-operative complications. Of all the basal anæsthetics in use, the speaker believed avertin to be the best. The patient was unconscious and was readily controlled with gas and oxygen, and—contrary to what was sometimes stated—the cough reflex was never abolished. The use of atropine, while necessary where ether was employed, was harmful with other anæsthetics, producing a type of extremely viscid mucus impossible to expel, and it was, in his opinion, a possible cause of atelectasis. He was in favour of passing an intratracheal tube as giving a better controlled and quieter anæsthesia than with the gas mask alone. The custom of some anæsthetists of passing a catheter into the bronchus of the affected side for suction purposes he believed to be harmful, sucking out not only mucus but air from the bronchial tree, with consequent collapse. Such suction should be confined to the trachea, where it was impossible with a small catheter to produce enough negative pressure to do any harm.

There was very little discussion after the meeting, the members probably feeling, as the Chairman suggested, that the subject was one for experts. Dr. James Watt referred to the difficulty that patients had in getting up sputum after a thoracoplasty. In the belief that this was due to pain, he had in the past given morphia to relieve it, but he had later come to believe that the patient had no desire to cough. X-ray films after operation showed extension of disease in a considerable proportion of cases, presumably due to the anæsthetic. Dr. M. Davidson spoke of the incidence of the complication of massive collapse or atelectasis. This was probably associated with more than one factor, but blocking of the bronchial tubes with viscid secretion was likely to be the main factor in its production. He asked whether it was customary to give atropine with morphine in the premedication treatment. Mr. L. Fatti thought that cyclopropane did not increase the bleeding any more than did gas and oxygen; he had not himself found it a serious complication. Omnopon and scopolamine dried the patient much better than atropine. Mr. R. C. Brock did not like scopolamine; the long period of recovery was undesirable. Atropine should not be given *after* operation. He was not convinced that it was an ideal anæsthetic; worse than the increase of bleeding was the tendency to produce toxicity. Local anæsthesia should, he thought, be used more. High spinal anæsthesia was best for such operations as lobectomy and pneumectomy.

Dr. Hunter, replying, said that the cyclopropane machines made in Great Britain were inefficient and inaccurate. The drug was toxic if pushed, and produced a liability to tachycardia, bradycardia, or cardiac arrhythmia. The Connell (?) CO_2 absorber was perfectly satisfactory. In answer to Dr. Davidson he said he never used atropine. He disagreed with Mr. Hunter about avertin, which he thought did definitely abolish the cough reflex. Mr. Hunter, replying, said he did not think the spread of disease after operation was due to the anæsthetic. His avertin cases had nothing else. The cough reflex was not lost unless the dose had been too great.

NORTH-WESTERN TUBERCULOSIS SOCIETY

A MEETING of the Society was held at the Tuberculosis Offices, Oxford Road, Manchester, on Thursday, May 26, 1938, when the following short papers were read by members, Dr. G. Jessel, President, being in the chair:

A Series of Cases of Pulmonary Tuberculosis treated with Cadmium.

Dr. Cornwall's thirty-six cases were all sputum positive and were divided into three groups—viz., those with good, fair, and bad prognosis.

The preparation used was 1 c.c. of cadmium sulphide 1 per cent. in sterile olive oil or colloidal cadmium sulphide 1 per cent. given intramuscularly twice a week—usually thirty doses. He obtained the following results: Group 1 (two cases): Improved. Group 2 (three cases): Two improved. Group 3 (thirty-one cases): The majority of these were very ill and were treated rather with the hope of relieving symptoms than arresting the disease, other forms of active treatment being contra-indicated; of this group seven were clinically improved. Dr. Cornwall suggested that cadmium was worthy of a wider trial, especially where gold therapy was contra-indicated.

The Interest that lies in the Microscopical Appearance of Sputum and Saliva in Pulmonary Tuberculosis.

Dr. Holmes illustrated her address on the above subject by numerous excellent drawings of slides as seen under the microscope. Having described in detail her technique in the preparation of these slides, she went on to discuss the typing of the tubercle bacillus in relation to the clinical picture. Her address evoked keen interest and a lively discussion followed. In replying to questions Dr. Holmes agreed with Dr. Lynn that gastric lavage often gave good results when no sputum was available, and was more frequently practised on the Continent than here. It was generally agreed that the long form of the tubercle bacillus in the sputum connoted the acute type of the disease, and the shorter bacilli a more chronic type. Where both occurred the prognosis was indicated by the predominant form, being more hopeful when there were more of the shorter form of the bacillus.

An Uncommon Complication of Sanatorium Treatment.

Dr. O'Reilly described two cases of undulant fever. The features of the two cases under observation were bouts of remittent fever from three days' to three weeks' duration, occurring over a period of three months. The temperature was highest at 4.0 p.m. and was often accompanied by slight rigor. Anorexia, nausea, and occasional vomiting were present during the period of pyrexia; there were no symptoms during the intervals except weakness. There was no loss of weight. Both cases showed an

absolute lymphocytosis, one a normal white cell count, the other a leucopenia. The sera of both agglutinated suspensions of *Bacillus abortus* in high dilutions (1 in 2,500). Both patients were accustomed to drinking raw milk. *B. abortus* has been found in 30 per cent. of random samples of raw milk.

The Problem of Late Diagnosis.

Dr. Scott investigated a series of 100 sputum positive male cases in Groups 2 and 3. By a series of tables he showed that the blame for the lapse of time occurring between the onset of symptoms and diagnosis might be equally shared by the patients themselves and the general practitioners. Young patients with an acute form of the disease sought advice earlier and were diagnosed sooner than cases in the older groups. Uninsured patients sought advice earlier and were diagnosed sooner than contributors under the National Health Insurance Scheme. Among other means of combating the scourge of tuberculosis in this country Dr. Scott suggested that more time should be devoted in the medical schools to the teaching of tuberculosis, particularly on the clinical side, and that greater examination importance should be given to the subject.

JOINT TUBERCULOSIS COUNCIL

A MEETING of the Council was held on Saturday, May 21, at the rooms of the Society of Medical Officers of Health, Russell Square. Dr. S. Vere Pearson was in the Chair. Dr. N. Lloyd Rusby and Dr. R. L. Midgley were welcomed as new members, representing the Tuberculosis Association and the Tuberculosis Group of the Society of Medical Officers of Health respectively.

Information concerning a proposed visit to this country of French tuberculosis physicians was discussed briefly, and the Council agreed to co-operating in every way with arrangements which the National Association and the Tuberculosis Association might make for our visitors.

The Council accepted with regret the resignation of Dr. F. G. C. Blackmore from the Council, and the secretary was instructed to convey to Dr. Blackmore the thanks of the Council for the work which he had done on behalf of the Council in the past. Dr. W. Brand, who has done so much for post-graduate study in this country, was elected a co-opted member of the Council.

No additional Committees were set up, but it was decided that the Artificial Pneumothorax (Dr. Traill, Convener), Employment (Dr. J. B. McDougall, Convener), Radiology (Dr. G. Jessel, Convener), Milk (Dr. C. O. Hawthorne, Convener), Gold (Dr. R. L. Midgley, Convener), Nursing (Dr. Carling, Convener), and the Finance and Publicity Committees should remain in office. The Committee dealing with work in the colonies is now to become the "Overseas" Committee, with Dr. F. Heaf as Convener.

By the requisite two-thirds majority the Council decided to make two

alterations to the constitution, which will allow of wider representation on the Council. Both motions were in the name of Dr. James Watt.

An important discussion concerning Memorandum 37/T was initiated by Dr. G. Lissant Cox, who moved that the Ministry of Health be asked to resume the publication of the summary of returns of work rendered to the Ministry under Mem. 37/T. Dr. Cox pointed out that the returns at present available from the Ministry do not allow of comparison being made between areas of similar size and population, and he felt that neither time nor expense necessary for the preparation of these returns should stand in the way of their publication. He did not suggest that they should necessarily be published yearly, but they should certainly, in his opinion, be available at two- or three-yearly intervals. Support for the motion was given by Drs. Jessel, Tattersall and Sutherland, and the Chairman pointed out that one of the great advantages in the returns was that they tended to stimulate the more backward local authorities. The observer from the Ministry of Health pointed out that the demands on the staff of the Ministry of Health were at the present moment very great, and that returns enabling local authorities to compare their own areas with county and county boroughs in England and Wales as a whole were still available for any local authority. He also stated that certain improvements had been made in the statistical information now being rendered by local authorities, and that in the event of additional information being published there would be certain alterations in the original Mem. 37/T.

The Council resolved that a deputation comprising Drs. Lissant Cox (Lancashire), Sutherland (Manchester), Tattersall (Leeds), and Prof. Jameson (London) should meet the Ministry to discuss more fully and report back to the Council.

The Chairman presented the report of the Finance and Publicity Committees, and some concern was expressed by certain members of the Council at the financial position of the Council, which depended almost entirely on affiliation fees for its existence. Despite this, many valuable reports had been published in the past, and the secretary was instructed to explore all possible channels for additional financial assistance.

Dr. G. Jessel (Lancashire), on behalf of the Radiology Committee, reported the co-option of four radiologists of wide experience to the Committee of which he was Convener. It may be some time before his Committee is in a position to report to the Council.

The Convener of post-graduate studies (Dr. Brand, London), in a letter to the Council, reported that Dr. Peter Edwards had consented to give two more courses—June 27-29 inclusive and September 26-28 inclusive. The Council also discussed the possibility of a study tour to Russia, but decided that this question be postponed for one year. Further post-graduate classes are being arranged, if possible, at Heatherwood Hospital and at Brompton Hospital in November of this year.

The Council decided unanimously that a list of subjects suitable for examination and investigation by the Council be prepared and submitted to the next meeting of the Council, which will be held on November 19, 1938.

REVIEWS OF NEW BOOKS

Workmen's Compensation for Silicosis in the Union of South Africa, Great Britain, and Germany. International Labour Office, Studies and Reports, Series F (Industrial Hygiene), No. 16. Geneva, 1937. Price 3s. 6d. Pp. 147.

This handy booklet gives a conveniently summarised account of the regulations governing claims for silicosis in the three countries named above. There are sharp differences between these countries, and these depend chiefly upon the differences which exist between the circumstances under which silicosis occurs. In South Africa the Reef is a formation which extends, perhaps, for about forty miles in length and concentrates the whole of the industry on its surface. In Great Britain and in Germany legislation attempts to deal with a situation in which silicosis is associated with various trades and occurs in various circumstances and in which the workers are exposed to differing risks. It is natural, therefore, that the scheme for examination of the men exposed to risk should be most elaborate and most suitable in the Union Government, where the concentration of work upon a small area and the fact that the authorities are dealing with one industry only render the effort less and allows of fairer treatment for the men, whether white or black. At the same time it must not be supposed that the task is easy or that the worker invariably gets such treatment as appears to him to be exactly fair, though it may be claimed that his rights under existing regulations are very well looked after. It is greatly to be regretted that the situation is less clear in England, where, with the best intentions, the Government remains rather at a loss to decide what exactly it is right and just to give compensation for; and the fact that an enquiry is now in operation to decide whether the coal industry is sufficiently provided for, or whether it would be as well to include persons now outside the scheme of legislation, must be taken as showing some indecision on this point. The regulations, however, have been drawn up with care and manifest an attempt to place compensation in the hands that deserve it. As to Germany, one is loth to draw conclusions without a greater degree of knowledge than the existing regulations afford, but it may be taken that there is compensation for those who are found to be suffering from silicosis.

We shall start by describing or quoting from the South African regulations. "Despite the fact that the expression miner's phthisis is used in the title of the Acts, this term does not reappear in the text thereof, where the terms currently employed are silicosis of the lungs (with or without tuberculosis) and tuberculosis of the lungs or of the respiratory organs."

Three stages of silicosis are distinguished in the Acts:

(*a*) An ante-primary stage when it is found that the earliest detectable specific physical signs of silicosis are or have been present, whether or not capacity for work is or has been impaired by such silicosis.

(*b*) A primary stage when it is found that definite and specific physical signs of silicosis are or have been present, and that capacity for work is or has been impaired by that disease, though not seriously or permanently.

(*c*) A secondary stage when it is found that definite and specific physical signs are or have been present, and that capacity for work is or has been seriously and permanently impaired by that disease, or when it is found that tuberculosis with silicosis is or has been present.

A person is deemed for the purposes of the Act to be suffering from tuberculosis whenever it is found either (*a*) that such person is expectorating tubercle bacilli, or (*b*) that such person has closed tuberculosis to such a degree as to impair seriously his working capacity and render prohibition of his working underground advisable in the interests of his health, tuberculosis within the meaning of the Act being tuberculosis of the lungs or respiratory organs.

Compensation is accorded for cases of disease or of death.

1. *Compensation for disease* is accorded in cases of silicosis, with or without tuberculosis, or tuberculosis without silicosis. (The native worker has rights similar to the miner.)

2. *Compensation in case of death* is accorded to dependants of miners or native labourers when death is due to silicosis or any other cause with which silicosis was present as a contributing or predisposing factor.

In the case of Great Britain, under " scope of legislation " the following industries are laid down:

(1) The metal grinding industries.
(2) The refractories industries.
(3) The sandstone industry.
(4) The various industries.

The refractories industries include processes carried on at mines, quarries, factories, and workshops at which refractory material containing not less than 80 per cent. total silica (SiO_2) is got or manipulated with a view to manufacture or sale. The sandstone industry, however, provides that the sandstone got, manipulated, or worked contains more than 50 per cent. of silica (free or combined). This must mean that in the sandstone industry exposure to the dust in question has had the effect of causing silicosis. One is tempted to ask why, in that case, a total of 80 per cent. is laid down in the refractories industries, but perhaps the intention is to treat specific cases exposed to a lesser amount under the " various industries."

The various industries, in fact, would appear to be a convenient escape from too close tying down in former years of the definitions by which compensation was given. It includes mining and quarrying of silica rock, getting and manipulation of granite, all underground operations and the breaking of ore above ground in the tin mines, manipulation and working

of silica rock, certain specified processes in potteries, coal mines, and iron ore (hæmatite) mines, foundries and metal works (but in the latter the reservation as to 80 per cent. silica comes in again).

These headings are more specifically dealt with in the original, but are mentioned here to show that Great Britain has a difficult problem to solve.

The Right to Compensation.

Compensation for silicosis—that is to say, fibrosis of the lungs due to silica dust, as well as silicosis accompanied by " tuberculosis " (this means, as stated in the different schemes, tuberculosis of the lungs)—if due to employment in an industry or process covered by the schemes, is provided, subject to conditions enumerated below, in cases of:

(*a*) Compulsory suspension from employment.
(*b*) Total disablement.
(*c*) Death.

Compensation is *not* given for tuberculosis *alone* or for suspension merely on account of inadequate physique.

Such is the general tendency of the law in Great Britain. It will be observed that, although compensation for tuberculosis alone is given in South Africa, it is specifically stated that it is not allowed in England. This may, perhaps, mean that in the majority of the cases no preliminary medical examination is made, and that, therefore, it is impossible to prove that the entrant was free from tuberculosis; but in any case the exclusion of tuberculosis alone is a fair and reasonable principle and need not concern us here. Of much greater importance is the reservation that the workman must, *within three years* previous to the date of the injury, have been employed in an industry or process covered by the scheme under which compensation is claimed.

In South Africa compensation is paid provided that the workman, other things being in order, " submits his claim *within five years* from the date at which he last worked underground at a scheduled mine within the meaning of the 1925 Act or preceding Acts."

This difference is of great importance to the miner, and it is to be hoped that the British restriction may in time be altered or withdrawn. In South Africa, in fact, the period of five years is considered too short in many cases, and, apart from the regulation laid down as a guide for general action, it is further stated that " if such a claimant is a resident in the Union, the Mandated Territory of South-West Africa, or the adjacent Protectorates of Bechuanaland, Basutoland or Swaziland, he can submit his claim at any time, even after five years, provided that he satisfies the Board that the disease is the result of underground work at a scheduled mine after August 1, 1908."

In South Africa, too, the very nature of the medical part of the adjudicating machinery is much more comprehensive than elsewhere, consisting, as it does, of the Silicosis Bureau, an organisation including a

director, a suitable clinical staff, and whole-time pathologists, who, in addition to work done for the South African Institute of Medical Research, give their complete attention to the problems reaching them from the Bureau.

In Great Britain the "medical procedure as regards compensation for silicosis is based on the operations and decisions of the Medical Board, the organisation of which is regulated by the Silicosis and Asbestosis (Medical Arrangements) Scheme dated 1931, and subsequent amendments. The Medical Board consists of specially qualified medical practitioners appointed by the Secretary of State under the chief medical officer, whose duty it is to supervise the working of the medical arrangements with a view to securing a uniform standard of efficiency. Their duties are to carry out the various medical examinations required on commencement of employment or periodically thereafter, or on the applications of persons desiring to claim compensation, or in connection with arbitration proceedings and reviews of weekly payments; and to issue the various certificates required under the compensation schemes."

It will be noticed that this organisation does not include pathologists. A Board may be very efficient at its proper jobs, but it cannot very well improvise a pathological service. This want is not very much noticed in the duties laid down for the members, but it is a part of the machinery which deserves to be bettered. The scheme lays down that "the certificate of death (Form A) is furnished by the Medical Board after a post-mortem examination of the deceased workman. The only exception to this rule is in cases where weekly payments under the compensation scheme were payable to the workman, and then only if the Medical Board is satisfied that a post-mortem examination is unnecessary. The post-mortem is not necessarily made by a member of the Board, but he must, if possible, be present, and, particularly if he is not, arrangements are usually made to enable the Board to examine the lungs and other material from the body if desired. It will be observed that the Board only certifies as to whether or not the death was caused by silicosis or by silicosis accompanied by tuberculosis; it does not certify the actual case of death apart from the disease."

There is much that one would like to refer to, but this review has already drawn to great length. The Appendices alone, including a report submitted by Lewis R. Thomas, Assistant Surgeon-General, Chief of the Scientific Research Division, U.S. Public Health Service, to the tenth meeting of the Correspondence Committee on Industrial Hygiene, well merit a longer mention than can be given them; and there is one describing the radiographic technique in respect of silicosis in the cases of South Africa and Great Britain that must be read carefully by all who are interested in the subject.